CERAMIC ABSTRACTS and THE BULLETIN

OF THE

AMERICAN CERAMIC SOCIETY

APRIL 15, 1945

MONTHLY PUBLICATION DEVOTED TO THE ARTS AND SCIENCES RELATED TO THE SILICATE INDUSTRIES

Micromax Controller which uses Rayotube in control of a Selas gas-fired tunnel kiln in plant of Lenox Inc., Trenton, N. J. Kiln has just come to new operating temperature; note smooth, even control curve.

HERE'S HOW LENOX, INC. INSTRUMENTED A 2350 F FIRING ZONE

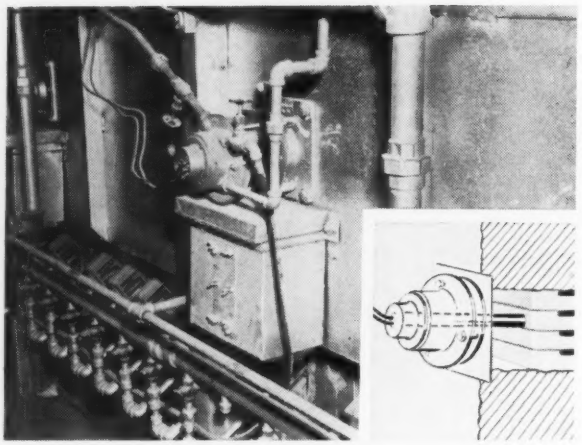
Control at 2350 F which is more accurate than many a control at lower temperature—that's the achievement of engineers who collaborated on the Selas kiln recently installed by Lenox, Inc.

This high degree of accuracy is being applied in the firing of a war product in which accuracy is essential—"Lenoxite" brand steatite insulators. And, while the accuracy at 2350 is outstanding, that is far below the temperature limit, for the equipment has operated with precision to a temperature of 3250 F.

This outstanding result is attained partly by taking an idea from standard metallurgical practice—by detecting the temperature with a Rayotube, aimed directly *onto* the saggers, instead of by a thermocouple *near* the saggers. Since ware and saggers are at identical temperatures, this bases the control on the actual condition of the ware. And since the Rayotube has no appreciable lag, all changes in fuel and air are made with great promptness by the micro-responsive Micromax Control Pyrometer.

Furthermore, fuel and air are both changed together—Micromax Electric Control is directly connected to both valves.

Jrl. Ad N-33B-664(4c)



Rayotube installed on side of kiln; and diagram showing how it sights directly on moving sagger. Connected to Micromax Controller shown above, the Rayotube thus gives control based on temperature of the actual ware.

The result is that temperature is always steady; and the Micromax record is usually a straight line showing only small jobs from time to time.

Further information about Micromax with Rayotubes is in Catalog N-33B, sent on request.

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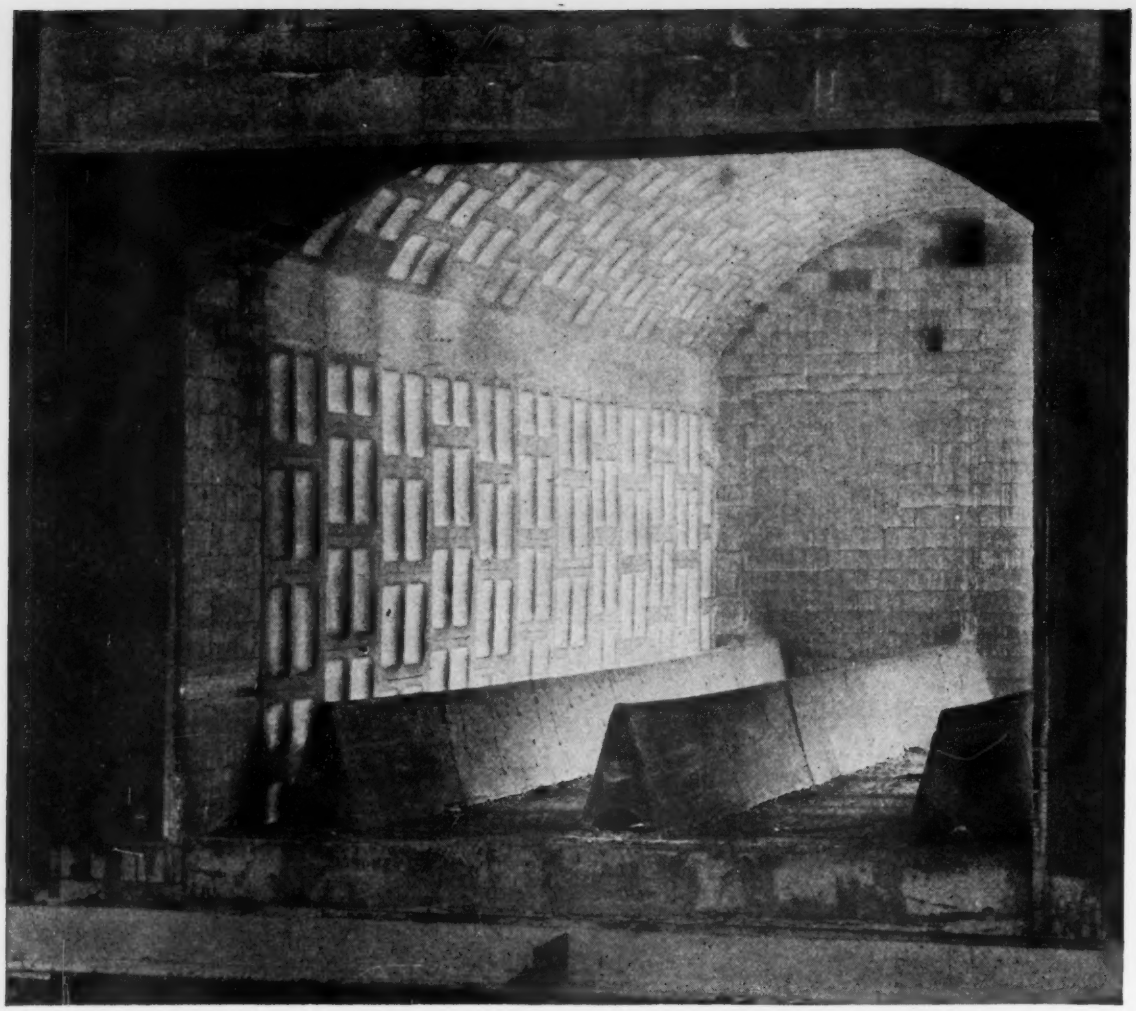

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Furnace loads were heavy. They averaged 4,500 pounds each and were left in the furnace for 4 hours. The schedule called for three loads each day. When changing loads, the furnace was cooled to 800°F. and then brought back to the operating temperature of 1295°F.

Only at the end of 1943—*after more than 6 years' total service*—did these excessive wartime loads take their toll. The bottom finally had to be replaced. Prior to that time, the only rebuilding necessary was to use four new "ALFRAX" aluminum oxide tile and re-set the others. The side walls and arch are still in excellent condition.

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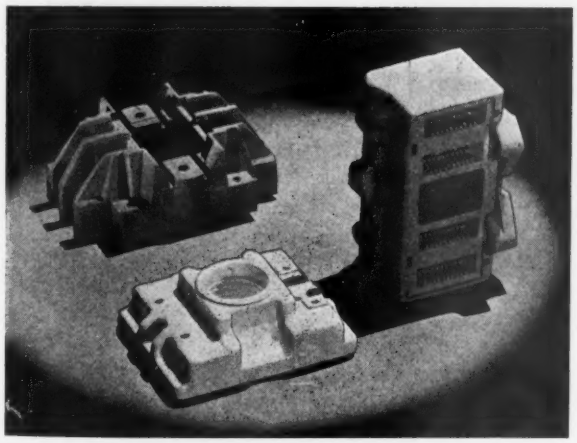

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SiO_2	49.36%	K_2O	9.28%
Al_2O_3	28.98	MnO	0.30
Fe_2O_3	0.08	SnO_2	0.18
Li_2O	4.20	Cr_2O_3	trace
Rb_2O	2.20	Fluorine	4.00
Na_2O	1.94		

Late shipments have analyzed between 4.12% and 4.40% Li_2O and from 0.05% to 0.08% Fe_2O_3.

POTENT FLUXING POWER

Jooste Lepidolite is a strong flux, a characteristic attributed to its potash, rubidia and fluorine content. Desired for many glass, glaze and enamel applications, especially where iron content must be low. Should be a valuable component of leadless and low-lead dinnerware and pottery glazes.

PRESENT AND PORTENT

Lepidolite is an easily melted source of alumina in combination with Lithia for opal and flint glass. Reports say that use of Lepidolite instead of cryolite in making opal glass reduces corrosion of refractory walls of the glass pots.

Thermal stability may be improved through lowering of the coefficient of expansion.

Lepidolite tends to reduce devitrification in the melt.

Harder surface on the finished glass may be produced. More "toughness" with less brittleness should be expected.

Some reports attribute to Lepidolite an increase in the index of refraction.

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We will gladly send samples of Jooste Lepidolite and quotations at your request.

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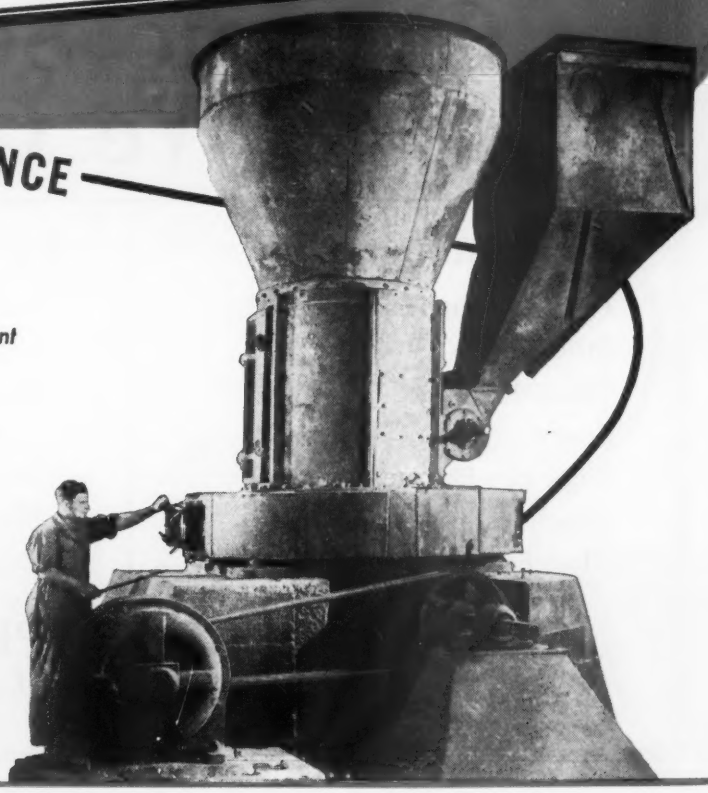
This is one of many types of mills used by Foote for producing from ores and minerals the grindings and granulations consumed by industry. The all-important control of particle size through grinding, and the processes related to grinding such as tabling, calcining, drying and magnetic separation are reduced to a science at Foote's three plants.



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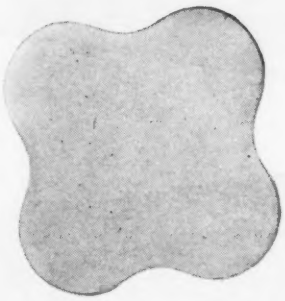

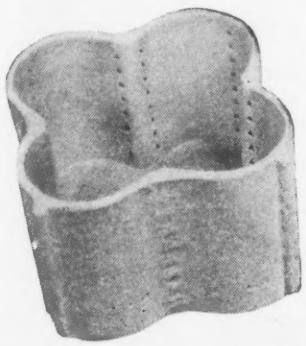

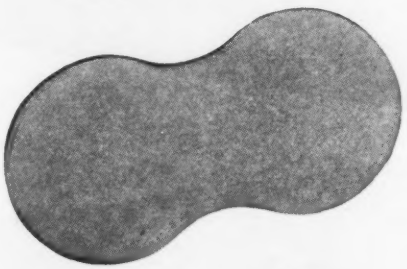

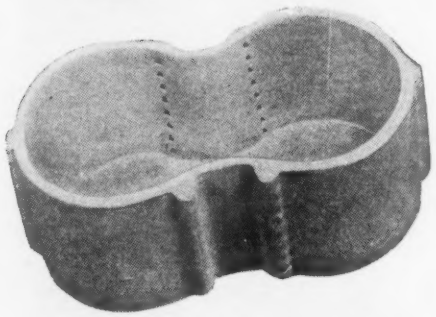

If you are looking for more *durable* kiln furniture—real tough, rugged, *thin-walled* refractories that will help reduce fuel bills and, incidentally, increase the "payload" capacity of your kilns—you'll find it here at CESCO, and in a wide variety of sizes and shapes.

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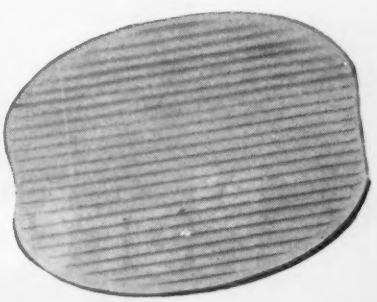
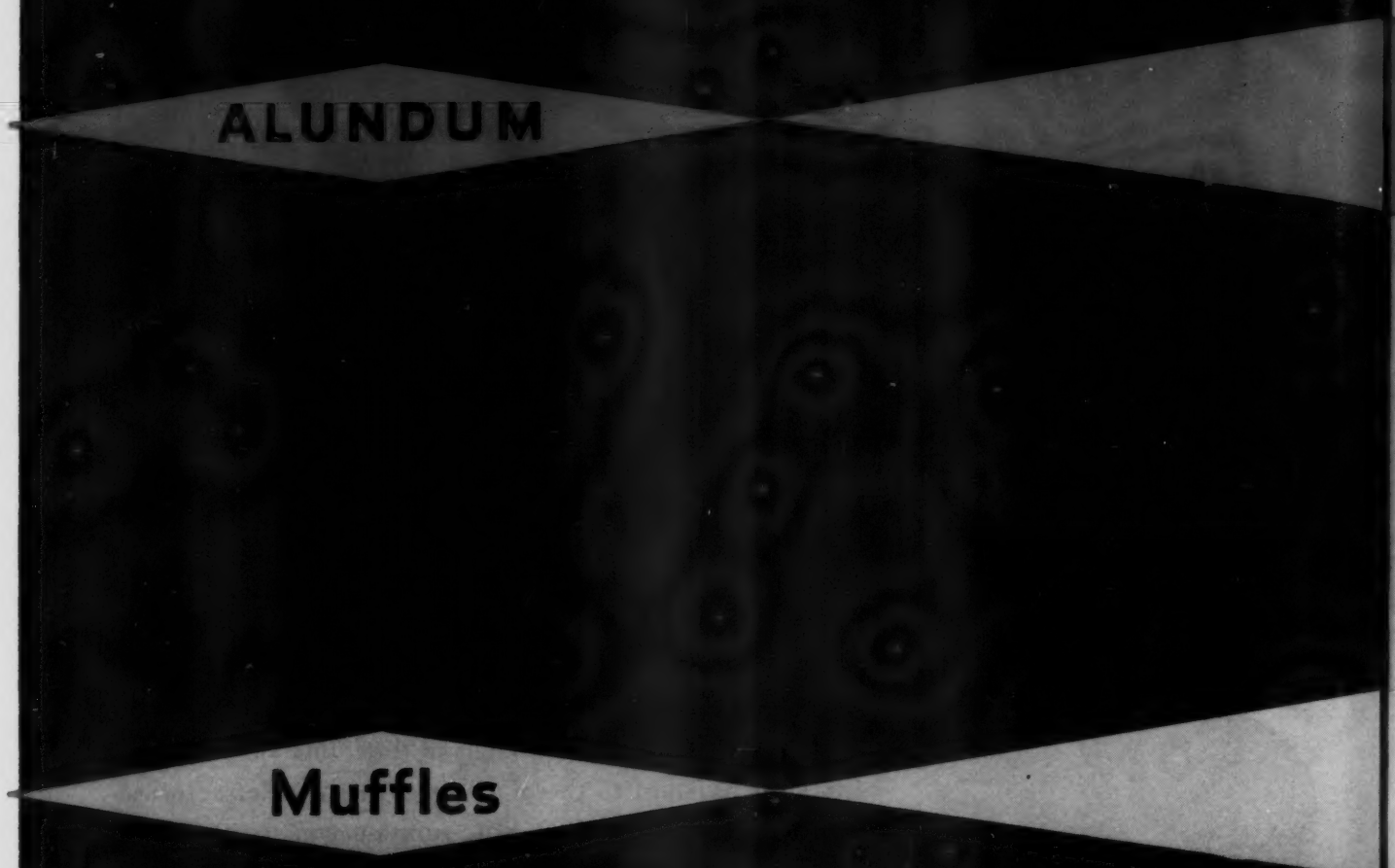


Serving the Enameling Industry



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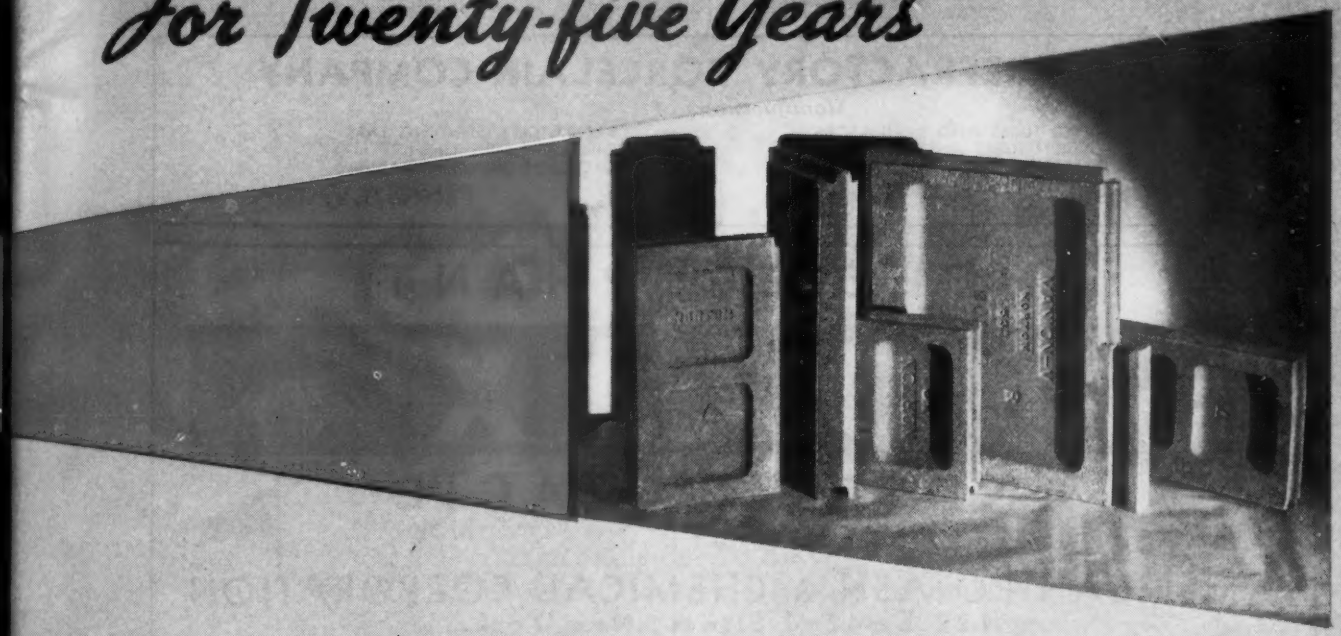
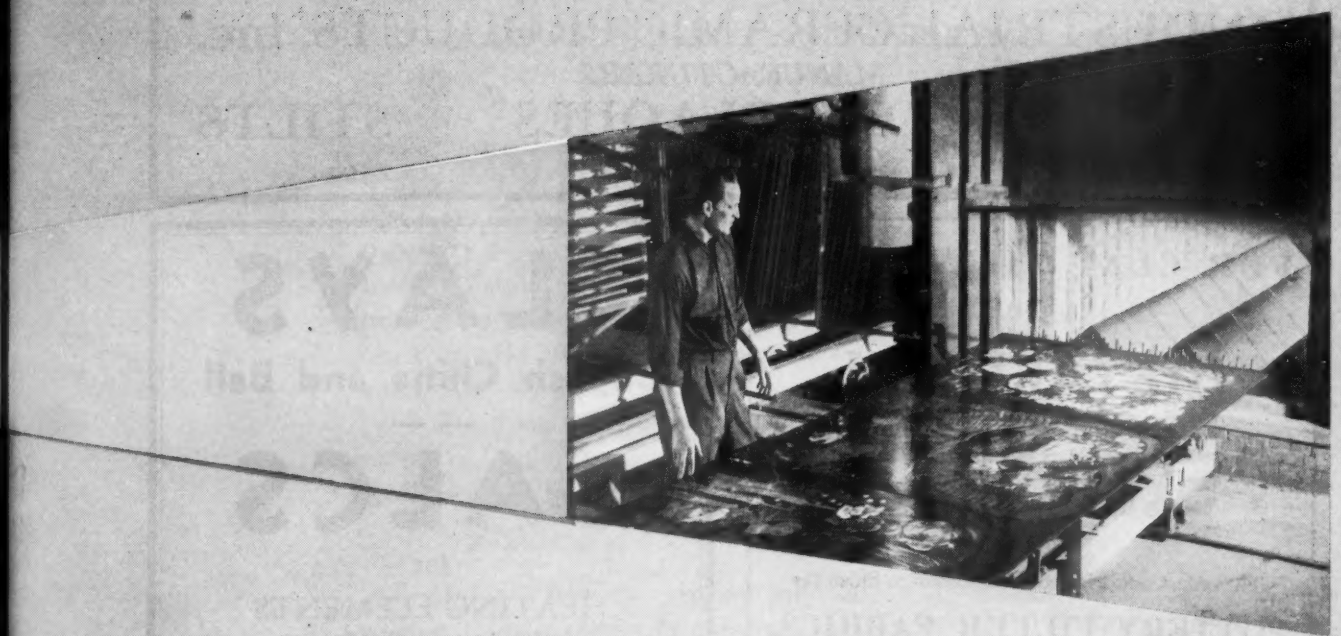
For Twenty-five Years





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Ti-Namel—The New Alloy Steel Base for Vitreous Enamel Also Lowers Cost of Product

For many years the Inland research staff has been studying and experimenting toward the development of a better base for porcelain enamel—a base that would simplify operations, reduce shop time and labor costs, and produce a superior product. The result of this intensive research is Inland Ti-Namel—the new titanium alloy steel.

During the research period Inland Metallurgists worked on almost every possible combination of alloy. Finally it was determined that titanium would combine with the carbon in the steel to form a sufficiently stable carbide which is essential for the successful application of a thin white cover coat or coats to a base material without the necessity of a ground coat. Then followed a long series of tests to establish the amount of the alloy needed and the process to be used in making this titanium steel. Finally open hearth tests were made and the steel was sent to enameling shops for actual tests in making commercial products. Not until all this preliminary work was completed did Inland announce Ti-Namel—the superior alloy steel base for better porcelain enameled products.

Pending patent applications on the new enameling process and product made thereby are owned jointly by Inland Steel Company and The Titanium Alloy Manufacturing Company under trust agreement.

We have a new descriptive bulletin on Ti-Namel and will be glad to send you a copy.

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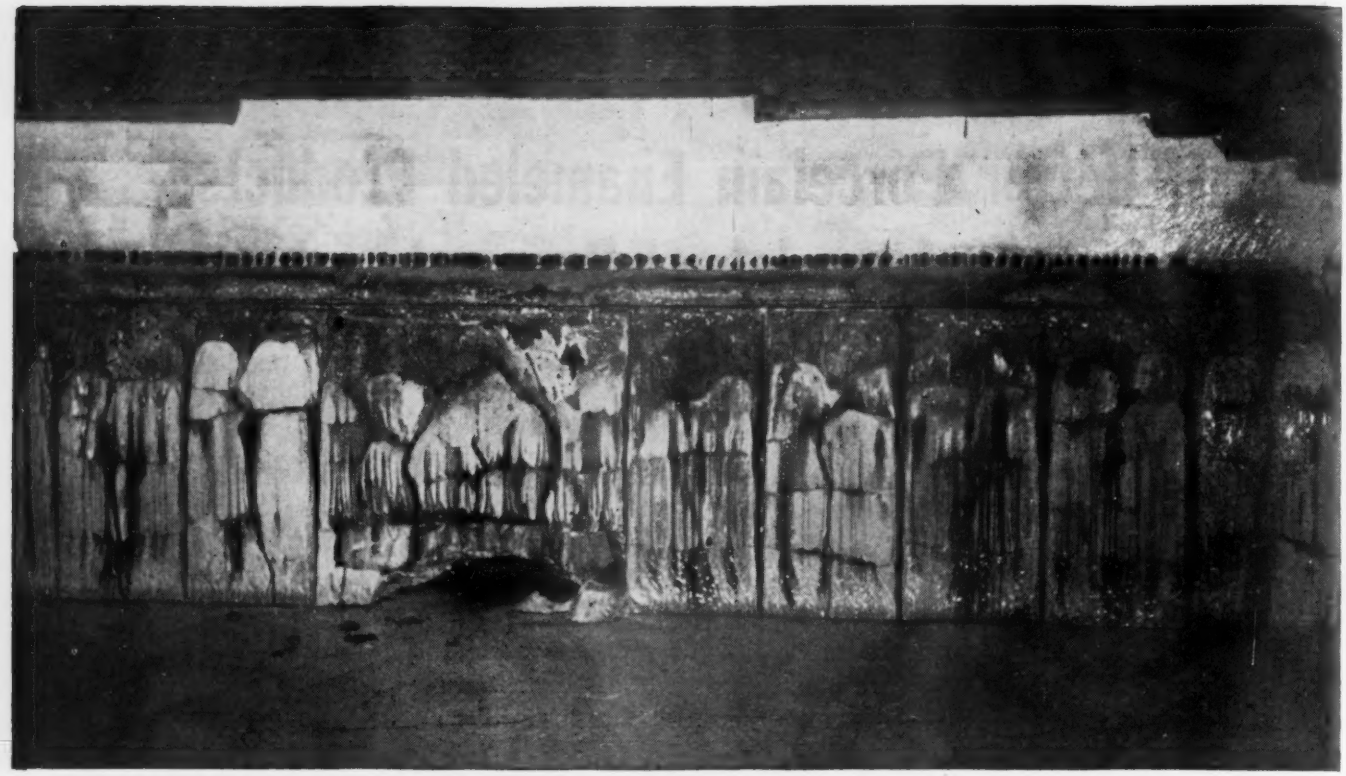
INLAND TI-NAMEL



207.81 Tons of Glass Per Square Foot Per Life!

SEVERAL months ago we reported the operating data of a Corhart Electrocast tank melting flint bottle glass, which had finished its first run, and was then operating on the second run of its campaign. As promised at that time, we are now reporting to you the outcome of the completed *two-run* campaign.

You may remember that on the first run, the tank produced 142.18 tons of glass per square foot. ***On the second run this tank produced 65.63 tons of glass per square foot, for a record of 207.81 tons of glass per square foot per life.***

The operating data for the complete two run campaign is as follows:

Melting Area 440 Sq. Ft.		Total Days Life	Total Operating Days	Idle Days	Total Tons Flint Glass	Tons Glass Per Sq. Ft. Per Life
1st Run	7/3/41 To 11/11/43	860	844	16	62559.19	142.18
	DOWN PERIOD			13		
2nd Run	11/24/43 To 11/15/44	357	352	5	28878.95	65.63
	Total	1217	1196	34	91438.14	207.81

At the end of the first run the Corhart Electrocast sidewalls and throat were left in place for the second run by overcoating at the metal line when repairing the superstructure. At the end of the second run, which was terminated for reasons other than failure, it was found that the overcoating on a portion of the sidewalls, and on the complete bridgewall, had not been needed for this complete campaign. In fact, the operator of the unit has reported that, in his opinion, much additional life still remained at the end of the second run.

If you have never fully investigated the possibilities of Corhart Electrocast balanced tanks, we would appreciate an opportunity to discuss the matter with you.

Corhart Refractories Company, Incorporated, 16th and Lee Streets, Louisville 10, Kentucky.

QUALITY ECONOMY ENDURANCE

CORHART ELECTROCAST REFRACTORIES

Ceramic Abstracts Section

Compiled by

THE AMERICAN CERAMIC SOCIETY

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PERIODICAL REFERENCE: The name of the periodical appears in italics, followed by the volume (bold-faced), issue number (in brackets), page numbers, and year (in parentheses).

Vol. 24 **April 15, 1945** **No. 4**

Abrasives

Hardness and softness. ANON. *Ind. Diamond Rev.*, **5** [50] 3–8 (1945).—A new aspect of hardness established by Späth (see "Physics . . .," this page) is discussed, i. e., its definition as load divided by removed volume; a supplementary value, softness, is the reciprocal value. It is shown graphically that the new definitions suggested simplify the study of scratch hardness, indentation, machinability, and wear. Brinell, Rockwell, Alpha, and Knoop hardness tests are reviewed in detail, and the rebound hardness test is also referred to. The Knoop hardness is not mentioned by Späth, but this part has been added to show how the Späth definition may be adapted to other hardness-testing methods. P.G.

Machining steel and cast iron with diamond? PAUL GRODZINSKI. *Ind. Diamond Rev.*, **5** [50] 18 (1945).—G. presents a historical review of some uses of shaped diamond tools for the purpose of machining steel and cast iron. In the case of cast iron, two articles were published in 1922 by G. T. Linting (*Amer. Machinist*, **57**, 437–39, 949–50 (1922)) on diamond boring tools and diamond tools in motor building. In 1932 a firm maintained that cast iron can be machined with diamond tools, and an extract of a report is reproduced. That steel can be machined with diamond was mentioned in Brit. Pat. 159,783 in 1920. The Franklin automobile factory first used diamond on aluminum piston turning in 1917. A Belgian firm, in a report published in 1928, discouraged the use of diamond. A negative view was also taken by an American firm in 1943. The Research Department of the Cincinnati Milling Machine Co. demonstrated in 1944 that a diamond tool does not suffer when machining soft steel. P.G.

Small-hole grinding with diamond-charged mandrels. F. C. VICTORY. *Amer. Machinist*, **89** [4] 107–10 (1945).—Round straight holes in dies and gauges can be produced to tenths faster with a mandrel charged with the proper grade of diamond dust than by the use of small mounted wheels; the method is especially efficient for holes smaller than 0.25 in. in diameter. Several examples illustrate the procedure. M.HA.

X-ray inspection of diamond die setting. ANON. *Ind. Diamond Rev.*, **5** [50] 9 (1945).—A method of X-ray inspection of diamond settings has been developed by the Kelley-Koett Mfg. Co., Covington, Ky. The radiographs taken indicate whether the center alloy properly surrounds the diamond and whether the diamond is lined up with the proper orientation. Radiographs of three sample nibs with diamonds mounted are shown. P.G.

BOOK

Physics and Technique of Hardness and Softness. (Physik und Technik der Härte und Weiche). WILHELM SPÄTH. J. Springer, Berlin, 1940. 250 pp., 214 illustrations. See "Hardness . . .," this page.

PATENTS

Abrading apparatus. W. L. KEEFER (Pangborn Corp.). U. S. 2,368,664, Feb. 6, 1945 (April 30, 1943); divided out of 2,246,522, June 24, 1941 (March 10, 1938) and 2,329,-203, Sept. 14, 1943 (June 21, 1941). 3 claims. (Cl. 51-9).—1. A rotor for a centrifugal abrading mechanism comprising a disk having a series of apertures therein and materials of different densities in the apertures to balance the disk for rotation, sufficient material being placed in each aperture to form a flush surface with the surface of the disk whereby no purchase surface is provided for flying abrasive.

Abrading and polishing device. WILLIAM KRIEGER. U. S. 2,370,864, March 6, 1945 (Jan. 27, 1943). 2 claims. (Cl. 51-59).

Abrasive article. G. F. KEELERIC. U. S. 2,370,970, March 6, 1945 (May 11, 1944). 5 claims. (Cl. 51-309).—1. A method of making an abrasive tool which comprises mounting abrasive particles on a support, electrodepositing metal over the particles and controlling the electrodeposition to build up a deposited layer which overlies the particles and is provided with an integral extension of deposited metal, the extension projecting from the face of the deposited layer opposite to that in which the particles lie, and affixing a tool body to the layer with the extension entering a cavity in the body.

Abrasive articles and methods of manufacturing. N. P. ROBIE AND O. L. MAHLMAN (Carborundum Co.). U. S. 2,369,689, Feb. 20, 1945 (Nov. 6, 1941). 12 claims. (Cl. 51-298).—1. An abrasive article comprising abrasive

grains and a hardened binder comprising the additive reaction product of a substantially neutral unsaturated monomeric material and an unsaturated esterification product of an aliphatic alcohol and a polybasic acid.

Aluminous material. H. N. BAUMANN, JR., AND R. C. BENNER (Carborundum Co.). U. S. 2,369,709, Feb. 20, 1945 (June 10, 1941; Jan. 24, 1944). 12 claims. (Cl. 51-309).—1. As a new article of manufacture, a sintered product consisting principally of crystallized alumina in which at least one oxide of the group consisting of Cr_2O_3 and V_2O_3 is contained in solid solution, the alumina also containing titanium atoms in the lattice thereof.

Cross-feed mechanism for grinding machines. R. S. PYNE AND E. A. ALLEN (Van Norman Co.). U. S. 2,370,580, Feb. 27, 1945 (Jan. 23, 1943). 7 claims. (Cl. 74–290).

Diamond dressing tool and method of forming. R. G. WILLIAMS. U. S. 2,368,696, Feb. 6, 1945 (Nov. 18, 1942). 4 claims. (Cl. 125-11).

Diamond wheel dresser. S. M. POLLARD AND V. W. WINDBLAD. U. S. 2,369,405, Feb. 13, 1945 (Feb. 26, 1943; in Canada Jan. 4, 1943). 2 claims. (Cl. 125-11).

Grinding or abrading machines. A. SCRIVENER, LTD., AND A. SCRIVENER. Brit. 566,630, Jan. 17, 1945 (June 26, 1943).

Grinding machine. S. E. WOODBURY (Reid Brothers Co., Inc.). U. S. 2,370,701, March 6, 1945 (April 13, 1943). 9 claims. (Cl. 51-231). L. B. PORTMAN, R. H. PORTMAN, AND F. J. ACTON. U. S. 2,370,813, March 6, 1945 (Sept. 21, 1942). 16 claims. (Cl. 51-166).

Grinding roll. A. E. HAMILTON. U. S. 2,368,760, Feb. 6, 1945 (Jan. 18, 1943; Oct. 15, 1943). 7 claims. (Cl. 51-194).

Lapping machine. H. S. INDGE (Norton Co.). U. S. 2,369,107, Feb. 6, 1945 (March 7, 1944). 8 claims. (Cl. 51-118).

Manufacture of abrasives. R. P. CARLTON (Minnesota Mining & Mfg. Co.). U. S. 2,370,636, March 6, 1945 (March 23, 1933). 1 claim. (Cl. 117-17).—The method of coating a backing with a pulverulent material of elongated dimensions.

Method and apparatus for manufacturing abrasive materials. EDWARD HURST (United Cotton Products Co.). U. S. 2,369,462, Feb. 13, 1945 (Jan. 22, 1941). 12 claims. (Cl. 51-297).—9. The method of manufacturing abrasive articles which comprises first forming a loosely woven, open, unconsolidated web of considerable depth from a plurality of thin, carded, sheer fibrous membranes, agitating the fibers of the membranes to bring the fibers of each sheer membrane into interlocking position with the fibers of adjoining membranes, thereafter projecting abrasive grain by means of an air stream into the interstices between the fibers of the loosely woven, open, and unconsolidated web structure, applying a suitable adhesive binder and consolidating the open fibrous structure to anchor the included abrasive grains by the closely surrounding fibers and adhesive, and thereby reducing the web to a relatively thin, strong, abrasive-included sheet.

Reinforced abrasive wheel. A. L. BALL AND P. H. WALKER (Carborundum Co.). U. S. 2,369,639, Feb. 20, 1945 (May 22, 1944). 15 claims. (Cl. 51-206).

Surfacing apparatus. L. A. PATT (Carborundum Co.). U. S. 2,370,323, Feb. 27, 1945 (Oct. 28, 1943). 8 claims. (Cl. 51-197).

Art and Archeology

Ceramic color decoration can help expand postwar markets for glass. ANON. *Glass Ind.*, **25** [8] 351–53, 378–79 (1944).—Improvements in colors, squeegee oils, methods, and equipment for decorating glass are outlined. A.P.

Ceramic sculpture. W. RUSCOE. *Pottery Gaz.*, **67**, 702 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [4] 30A (1943).—Three methods of modeling are noted. The development of ceramic sculpture from earliest times is traced, particular attention being paid to early Staffordshire figures.

Ceramicenter, Inc. S. L. GORDON. *Bull. Amer. Ceram. Soc.*, **24** [3] 112 (1945); see *ibid.*, **21** [7] 148; [11] 301 (1942).

Frank Hurlbutt, connoisseur and author. F. S. MACKENNA. *Apollo*, p. 1 (July, 1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [9] 108A (1942).—An illustrated addendum to Hurlbutt's monographs on Derby, Bow, Bristol, and Chelsea ware.

Bernard Leach—potter. B. MARSH. *Apollo*, **37**, 14 (1943); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [5] 38A (1943).—Leach's work, first in Japan as pupil of and finally as successor to Ogata Kenzan, and then at St. Ives, Cornwall, is briefly described. Examples of his ware are illustrated; these are chiefly stoneware, but incised celadon is also represented.

Neglected Liverpool engravers. H. B. LANCASTER. *Apollo*, p. 22 (July, 1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [9] 108A (1942).—A short account is given of the following engravers of Liverpool pottery: Burdett, Carver, Robinson, Evans, and Billinge.

Old English lusterware. ANON. *Apollo*, **37**, 10 (1943); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [5] 38A (1943).—Lusterware was introduced in the 18th century, but by whom is not definitely known. Copper luster was the first to be made; the firing temperature was 650°C. Other lusters, including the mottled effect known as Sunderland luster, are discussed. Further decoration was applied by painting or stenciling; the former is called "resist" luster. The manufacture of this ware in the 19th century is briefly considered.

A. E. Waller visits Rowantrees Kiln. LAURA S. PADDOCK. *Good News* (Columbus, Ohio, Society for Hard of Hearing), Jan., 1945; reprinted in *Bull. Amer. Ceram. Soc.*, **24** [3] 94 (1945); see *ibid.*, [2] 43–46.

BOOK

Measurement of Colour. W. D. WRIGHT. Adam Hilger, Ltd., London, Nov., 1944. vii + 223 pp., 65 figures. Price 30*s.*, postage 9*d.* Obtainable in U. S. for $9.75 + postage from Jarrell-Ash Co., 165 Newbury St., Boston, Mass.—W. gives a comprehensive but concise account of the principles and methods of color measurement and specification, matters of increasing importance in several branches of science and industry. He has been engaged for many years at the Imperial College of Science on research into various problems of color vision and color measurement, and the results of some of his earlier work were incorporated in the data adopted by the Commission Internationale de l'Éclairage to define the color-matching characteristics of the standard observer for colorimetry. Visual and photoelectric instruments are described in the book, as well as the relation of color physics to many technical processes. The chapter topics are (1) radiation in the visible spectrum: its emission, absorption, and reflection; (2) radiation in the visible spectrum: its reception in the eye; (3) the trichromatic system of color measurement; (4) colorimeters: their design and use; (5) spectrophotometry applied to the measurement of color; (6) the color atlas as a substandard of color measurement; and (7) practical applications of colorimetry. W. devotes nine pages to condensed tables. A thorough index of author names and subject titles is provided. R.C.P.

Cements

Acidproof cement. ANON. *Chem. & Met. Eng.*, **52** [1] 144 (1945).—Properties of an acidproof cement, Duracite, containing furan-base resin, are given. B.C.R.

Designing Portland-cement clinker. C. J. KNICKERBOCKER. *Rock Products*, **48** [1] 194, 236 (1945).—The use of charts for determining the approximate percentage of calcium silicate and the estimation of the compound composition of Portland cement or cement clinker are discussed. B.C.R.

Latest investigations on hydraulic binders. RENÉ FERET. *Ann. Ponts Chaussées*, **112**, 595–618 (1942); abstracted in *Chem. Zentr.*, **1943, I** [21] 2230.—Experiments (interrupted by the destruction of the laboratory in Boulogne-sur-Mer) permitted the conclusion that modern types of cement possess greater safety and strength for structures under sea water than the former simple Portland cements. A direct relation between their chemical resistance and mechanical strength, however, does not exist. The corrosion in sea water is to a large extent the same as that found on specimen cubes in $MgSO_4$ solution. The linear relations previously found between tensile, compressive, and bending strengths on the one hand and the volume factor, γ, on the other were, however, fully confirmed. M.HA.

Enamel

Determination of weight of nickel deposited by nickel dip. J. M. ZANDER. *Better Enameling*, **16** [1] 8–9 (1945).—With the use of a nickel dip in the preparation of steel surfaces for vitreous enameling, a determination of the actual weight of the nickel deposited provides an over-all picture of the quality of the surface preparation. Determine the amount of nickel deposited as follows: Dissolve the nickel coating from a 2-in. square sample cut from a test plate with 30 ml. of 1:1 HCl and 10 ml. of 1:1 HNO_3 in a 400-ml. beaker. Heat until the nickel has dissolved, washing the plate off with hot water. Transfer to a 250-ml. beaker and evaporate to 75 ml. Cool and add 25 ml. of 25% citric acid solution and NH_4OH until the solution becomes green. (**1**) Cool to 60° to 70°F. and add 1 ml. of $AgNO_3$. Add NH_4OH until the precipitate just dissolves and then add 1 ml. more. (**2**) Add 6 to 8 drops of KI solution as an indicator and sufficient KCN in slight excess of that required to dissolve the precipitate. (**3**) Titrate with $AgNO_3$ until a slight cloudiness appears. (**4**) To 90 ml. of H_2O, add 1 ml. of NH_4OH, 10 ml. of KCN, and 6 to 8 drops of KI and titrate with $AgNO_3$ until slight cloudiness appears to determine the strength of KCN relative to that of $AgNO_3$. Grams of nickel deposited per sq. ft. of test plate = ml. KCN (**2**) × ($AgNO_3$/KCN) (**4**) − ml. $AgNO_3$ (**1** plus **3**) × 0.002934 × 18. B.C.R.

Improved method of salvaging and reconditioning cover coat booth scrapings. AL AULT. *Better Enameling*, **15** [12] 4–7 (1944).—Reprocessing by either remilling in a spare mill or blunging is satisfactory. After conversion of the reclaim to slip form, pass the slip through a Rotospray incorporating an 80-mesh screen to remove the large particles of foreign material and then through a magnetic separator (screen type). Run the enamel into a settling tank to which additional water and 2 to 3 oz. of sodium pyrophosphate per 100 lb. of reclaim are added. Decant the water through a series of pipes (illustrated). Discard the layer of fines present on top of the settled enamel. Remove the cake, dry, and bag for use. Practically all clay, opacifier, and other mill additions are removed by this treatment. B.C.R.

Kolene process for cleaning enameling steel. J. H. SHOEMAKER. *Better Enameling*, **15** [12] 18 (1944); *Enamelist*, **22** [5] 11–14 (1945).—The Kolene process is designed to remove from the surface of the steel both foreign materials, such as grease, oil, marking crayon, drawing compounds, etc., and such ingredients as S, Si, P, Mn, and C, though the percentages be small. This is accomplished by immersion in a bath of molten salts which form reducing or oxidizing members when the bath is agitated electrolytically. The bath is operated at 850°F. at an amperage of 8 to 25 amp. per sq. ft. of work to be cleaned. A reduction cycle is used for the removal of oxides, and an oxidation cycle for other contaminants. Steel or gray-iron castings can be prepared for enameling by this method. Tests are being made for adapting this procedure to malleable castings and other types of steel. B.C.R. & V.D.F.

Molybdenum in enamels: III, Typical molybdenum enamels; IV, White molybdenum enamels. KARL KAUTZ. *Jour. Amer. Ceram. Soc.*, **28** [3] 76–89 (1945); for Part **II** see *ibid.*, **25** [6] 160–63 (March 15, 1942).

Nickel dip in preparing steel for enameling. J. M. ZANDER. *Better Enameling*, **15** [10] 4–6 (1944).—The use of a nickel dip has frequently made possible the successful enameling of very inferior grades of steel. A nickel dip or other treatment of the steel surface appears essential for the successful application of one-coat white enamel; for this purpose a heavier nickel deposit is necessary for adherence. Heavier nickel deposits may be obtained either by increasing the time of immersion or by the use of a higher bath temperature, neither of which is desirable from an operation standpoint. Although present pickling practice recommends the operation of the nickel bath at a pH of 5.4 to 6.2, tests have shown that with a pH of 3.0 to 4.0 at 165°F. and a 5-min. immersion time, a satisfactory coating of nickel to promote adherence of a one-coat enamel can be obtained. Rigid control of pH and temperature will result in more uniform nickel deposits. B.C.R.

PATENTS

Production of superopaque vitreous enamels. P. C. STUFFT (Pemco Corp.). U. S. 2,370,695, March 6, 1945 (June 21, 1940). 3 claims. (Cl. 106-48).—1. The method of producing opaque zirconium-opacified frit comprising introducing zirconium-opacified molten frit-forming material into a quenching bath maintained at a temperature between 180° and 205°F., whereby there is produced a frit characterized by uniform opacity, the frit maintaining its uniform opacity and covering power upon firing and refiring.

Glass

Cellulated glass blocks for insulation. ANON. *Heating & Ventilating*, **42** [2] 63–65 (1945).—A new development in the field of thermal insulation is known as PC Foamglas. It is a cellular material (rather than porous) and is made up of 15 parts air and 1 part glass. Being a true glass, it has permanency and is impervious to water, acid atmosphere, vapor, fumes, and all acids except hydrofluoric and hot phosphoric acids. It is incombustible and light in weight. 6 illustrations. M.R.

Colored glasses: I and II. W. A. WEYL. *Glass Ind.*, **25** [6] 262–63; [9] 405–406 (1944).—A review by N. J. Kreidl. See *Ceram. Abs.*, **23** [4] 71 (1944); **24** [1] 7 (1945). A.P.

Determination of refractive indices. O. M. FERGUSON. *Optician*, **108**, 198, 216–18, 236–38, 255–57 (1944). A.P.

Experiments on the six focal lines due to reflections at the surfaces of two plano-cylindrical lenses. G. F. C. SEARLE. *Phil. Mag.*, **35** [246] 477–91 (1944).—The

phenomenon of the six focal lines is discussed in detail with accompanying calculations. Application of the phenomenon is made to optical systems. S.Z.

Flat-glass manufacture in Monterrey, Mexico. ANON. *Chem. & Met. Eng.*, **52** [1] 170 (1945).—The demand for flat glass is being met by local producers at a cost 30% less than that of glass imported from the U.S. Plate glass in various grades is also made. B.C.R.

Future applications of glass. ALEXANDER SILVERMAN. Read before St. Louis Section, American Ceramic Society, Nov., 1944; abstracted in *Amer. Glass Rev.*, **64** [7] 18 (1944). A.P.

Glass containers and closures. F. C. FLINT. Read at sixth annual conference, Packaging Institute, Inc., Nov., 1944; abstracted in *Amer. Glass Rev.*, **64** [7] 10, 19–20 (1944). A.P.

Glass in Pittsburgh. ALEXANDER SILVERMAN. *Pitt* (Univ. of Pittsburgh), **1944–45**, No. 20, pp. 12–13.—A brief history.

Glass theses at Alfred. S. R. SCHOLES. *Glass Ind.*, **25** [9] 399–401, 424 (1944).—One requirement for the degree of Bachelor of Science in Glass Technology at the New York State College of Ceramics is preparation of a thesis. To illustrate the kind of work done by the undergraduates, S. reviews "Measurement of the electrical conductivity of a glass" by Frank L. Cornish and "Pyrex-brand chemical glass as bond in porcelain" by Thaddeus A. Kupinski. A.P.

Glass is vital to research at Edgewood Arsenal. ANON. *Glass Ind.*, **25** [8] 354–57, 369 (1944).—Nowhere is the importance of glass in the war effort better exemplified than in the Chemical Warfare Service Arsenal at Edgewood, Md. Fourteen photographs illustrate the products and equipment of the Arsenal's glass-blowing laboratory. A.P.

HF resistant glass. ANON. *Glass Ind.*, **25** [12] 548–49 (1944); *Chem. & Met. Eng.*, **52** [1] 139 (1945).—Physical properties of the glass are compared with those of soda-lime and borosilicate types. Raw-material cost is about 20 times that of ordinary glass. Flat glass may now be obtained through the Pittsburgh Plate Glass Co. See *Bull. Amer. Ceram. Soc.*, **24** [1] 40–41 (1945). B.C.R. & A.P.

Mercury mirrors in 1942. B. SCHWEIG. *Glass*, **19** [10] 269 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [1] 5A (1943).—The mercury mirror went out of general use toward the middle of the last century. A British firm of instrument makers still uses the process, however, which is described.

Natural gas in glass manufacturing. JOHN W. FISHER. *Ind. Gas*, **23** [1] 18–19 (July, 1944).—A general description of the application of natural gas in the glass-manufacturing plant of the Ball Brothers Co., Muncie, Ind. 5 illustrations. H.K.R.

New uses for glass. H. SEYMOUR. *Electrician*, **132** [3423] 13 (Jan., 1944).—General. H.K.R.

Pittsburgh Glass buys coast alkali business. ANON. *Pit and Quarry*, **37** [8] 58 (1945).—The Pittsburgh Plate Glass Co. Columbia Division has acquired the plant and sales organization of the Pacific Alkali Co. The plant is located at Bartlett, Calif., and its products include soda ash, borax, and sesquicarbonate of soda. M.R.

Possibilities of glass in homes. ANON. *Amer. Glass Rev.*, **64** [15] 5 (1945).—Four "glass craft rooms" at the Joseph Horne Co. department store in Pittsburgh display the uses to which structural and decorative glass may be put in home interiors. A.P.

Review of events in the glass industry during 1944. ANON. *Amer. Glass Rev.*, **64** [15] 7–10, 12, 17, 19–21; [16] 10, 12, 14, 17, 20–21 (1945). A.P.

Significance of new data on combinations of plastic and glass fibers. F. W. PRESTON. *Glass Ind.*, **25** [6] 266–67, 284–85 (1944).—P. discusses the plastic-supported glass net whereby the plastics man utilizes the phenomenal properties of glass, unique in a structural material. The functions of the plastic are to support the glass filaments continuously, to protect the fibers from abrasion, and to act as a bridge for transferring the stress from one fiber to another. Forming the glass into fibers has the effect of stopping a crack before it goes far, since each fiber must be broken individually. The Young's modulus of elasticity of the combination is between two and three million pounds, which is lower than that of glass or metal but higher than that of plastics. The consequent gain in flexibility leads to improved impact resistance. See *Ceram. Abs.*, **23** [7] 123 (1944). A.P.

Supreme Court upsets 1932 decree in Hartford-Empire–Hazel-Atlas patent suit. ANON. *Glass Ind.*, **25** [6] 264, 275 (1944).—By a five-to-four decision, the Supreme Court has ruled that the Third Circuit Court of Appeals could upset a ruling made in 1932 in favor of the Hartford-Empire Co. The minority opinion is reviewed at length. A.P.

The Johnny Bull, trail blazer in bottlemaking machinery. ANON. *Glass Ind.*, **25** [2] 63–65, 78 (1944).—The manually operated three-man "Johnny Bull" or English Machine was said to be the first semiautomatic machine to make large narrow-neck bottles on a commercial basis. Use of the machine in this country reached its peak in 1914 with 114 machines in about fourteen different factories. A.P.

War conditions result in improved quality and mass production in Swedish glass. ANON. *Glass Ind.*, **25** [11] 498 (1944).—Reduction in the export market and a campaign to make consumers of lower-price merchandise beauty conscious have brought about changes in Sweden's glass-manufacturing activities. Examples of the low-priced products of the Eda, Kosta, and Orrefors glassworks are shown in five photographs. A.P.

PATENTS

Apparatus for bending glass. WILLIAM OWEN (Pittsburgh Plate Glass Co.). U. S. 2,370,575, Feb. 27, 1945 (Aug. 4, 1943). 13 claims. (Cl. 49-7).

Apparatus for handling and heat-treating glass. A. H. VAUGHAN (Electric Furnace Co.). U. S. 2,370,381, Feb. 27, 1945 (April 19, 1940). 33 claims. (Cl. 49-1).

Apparatus for tempering glass. O. H. PADDOCK AND J. L. DRAKE (Libbey-Owens-Ford Glass Co.). U. S. 2,369,368, Feb. 13, 1945 (July 19, 1940). 9 claims. (Cl. 49-1).—6. In apparatus for bending and tempering glass sheets, means for supporting the sheet heated to a temperature approximately the softening point of the glass in a vertical position, bending mechanism including opposed mold carriages, molds carried by the carriages, means for mounting the carriages for reciprocating movement toward and away from one another to bend the sheet between the molds to the desired curvature, means for reciprocating the carriages, and cooling mechanism including opposed cooling elements mounted above the bending mechanism for movement into cooling position at opposite sides of the glass sheet and means for moving the cooling elements downwardly into the cooling position to effect cooling of the sheet after it has been bent between the molds and the molds have been moved out of contact with the sheet surfaces.

Glass annealing and method. E. D. TILLYER AND J. W. FORD (American Optical Co.). U. S. 2,369,189, Feb. 13, 1945 (June 30, 1942). 3 claims. (Cl. 49-89).—The method of determining the degree of anneal or compacting of a piece of glass of a known composition comprising subjecting the piece of glass and a test piece of glass of substantially the same composition but of a known maximum index of refraction when completely annealed or compacted to an annealing cycle, determining the index of refraction of the test piece after passing through the annealing cycle to determine its degree of anneal or compacting by comparing the index of refraction of the test piece, at the completion of the annealing cycle, with the known maximum to thereby determine the degree of anneal of the piece.

Glassware-forming apparatus. EDWARD DANNER. U. S. 2,370,618, March 6, 1945 (June 10, 1940). 5 claims. (Cl. 49-17.1).

Glassware-spraying apparatus. A. S. JACKSON AND E. W. SUMMERS (Owens-Illinois Glass Co.). U. S. 2,369,737, Feb. 20, 1945 (June 19, 1942). 3 claims. (Cl. 91-45).

Glassworking apparatus. R. HADDAN. (Corning Glass Works). Brit. 566,628, Jan. 17, 1945 (May 24, 1943).

Lens edge grinding machine. J. C. ANDERSON. U. S. 2,369,114, Feb. 13, 1945 (Oct. 17, 1941). 11 claims. (Cl. 51-108).

Manufacture of spun glass fibers. PIERO MODIGLIANI (Owens-Corning Fiberglas Corp.). U. S. 2,369,481, Feb. 13, 1945 (March 16, 1939; in Italy March 22, 1938). 11 claims. (Cl. 28-1).

Manufacturing contact lenses. G. J. SHELDON (Bausch & Lomb Optical Co.). U. S. 2,369,758, Feb. 20, 1945 (Feb. 3, 1941). 8 claims. (Cl. 18-47.5).

Metalizing glass. C. D. HAVEN (Libbey-Owens-Ford Glass Co.). U. S. 2,369,350, Feb. 13, 1945 (Aug. 22, 1940; Feb. 11, 1942). 4 claims. (Cl. 117-123.1).—2. The process of metalizing glass, including the step of spraying a molten metal alloy upon the glass comprising approximately 1.75 to 2.25% titanium, approximately 0.40 to 0.60% chromium, and the remainder substantially all copper.

Methods and apparatus for electric glassworking. R. HADDAN. Brit. 566,629, Jan. 17, 1945 (May 24, 1943).

Mineral-wool apparatus. E. R. POWELL (Johns-Manville Corp.). U. S. 2,369,605, Feb. 13, 1945 (Dec. 9, 1941). 15 claims. (Cl. 83-91).

Production of stemmed glassware. UNITED GLASS BOTTLE MANUFACTURERS, LTD., T. C. MOORSHEAD, AND E. P. DORMAN. Brit. 566,519, Jan. 17, 1945 (May 26, 1943).

Transmission film for glass and method for producing. F. L. JONES AND T. J. ZAK (Bausch & Lomb Optical Co.). U. S. 2,369,741, Feb. 20, 1945 (Nov. 8, 1940). 9 claims. (Cl. 49-79).—7. In a method of providing a surface film on a glass body which consists of a single homogeneous vitreous phase formed of a network of strongly bonded silicon atoms to which weakly bonded elements other than silicon are joined by oxygen linkages, the steps of leaching out from the glass consisting of the single homogeneous vitreous phase primarily the weakly bonded elements by a leaching agent which will remove the weakly bonded elements in the form of soluble compounds and leave on the body a surface film which is rich in silica and rendering the surface film substantially impenetrable to leaching agents by heating the glass body to a temperature which is relatively high but below the softening point of the glass body until the surface film is densified and rendered stable against growth.

Structural Clay Products

Ceramic assembly units for temporary buildings. G. PFISTER. *Tonind.-Ztg.*, **66,** 205 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [3] 21A (1943).—A proposed system of "unit" building construction for shelters, garages, farm buildings, etc., consists of hollow brick having grooves in the sides by means of which they may be threaded onto reinforcing steel rods which are afterward cemented in the grooves, the whole forming a strong pillar. The pillar units are notched so that wall units in the form of long, hollow brick may be slid between adjacent pillars. Two wall units, separated by an air space, form the wall thickness. The manner of attaching the roof beam is shown.

Cooling and specific heat of dry and moist natural and artificial building materials. F. GEIGER. *Tonind.-Ztg.*, **66,** 113 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [1] 5A (1943).—The great influence of absorbed moisture on the thermal properties of building brick in the temperature range −25° to +50°C. is demonstrated.

***Frost resistance of natural and artificial [building] stones.** FRIEDRICH GEIGER. *Tonind.-Ztg.*, **65** [66] 675–79 (1941).—When planning buildings, etc., the resistance of the building materials to frost should be considered as carefully as the other properties. A setup for testing the frost resistance is described, and results are quoted. Several time-temperature curves for freezing and thawing are illustrated for various natural and artificial materials. Photographs of frost damage are shown. M.Ho.

Heat transmission through walls and roofs. A. F. DUFTON. *Jour. Inst. Heating & Ventilating Engrs.* [London], **10,** 65 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [4] 29A (1943).—A laboratory is described consisting of 6 chambers, each 8 ft. in each direction. The north wall of each chamber forms the test wall and is replaceable. Coefficients of heat transmission were determined for solid and cavity walls and for roofs of various types of building materials. Thermal transmittance values were obtained varying from 0.25 B.t.u./ft.²/hr./°F., for an asbestos cement roof having a double aluminum-faced paper lining, to 1.50 B.t.u. for plain tiling on battens; when the tiled roof was boarded and felted, the heat loss was reduced to 0.35 B.t.u.

Lamination in brick. H. WEGENER. *Tonind.-Ztg.*, **65,** 466 (1941); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [8] 94A (1942).—If there is a difference between the internal friction and the tenacity of the material being extruded, there is a tendency for lamination to arise in the cylinder; the parts which are easily moved go the way of least resistance, and thus a certain separation occurs. Diagrams show lamination formation and the flowing of the clay into the mouthpiece through a pug with direct outlet and also through a pug with side outlet. The differences in velocity between the edge and center zones, which first occur in the mouthpiece but are also present at the end of the cylinder, cause partial separation along the planes of lamination. The longer the mouthpiece, the greater is the danger of this occurring; the mouthpiece, therefore, must be kept as small as possible, and the hub of the outlet knife should be made larger. The shaft acts as a check on the velocity of the center zone. To improve flow conditions, the hub itself should be made larger. Laminations appear if the feed of the clay bodies takes place through a piston instead of through a screw. The pointed-shaped laminations which appear in the body of pressed tile are described and illustrated. Cracks also occur if the exit holes for the excess body are too big and the flowing into the narrow cross section of the frame occurs too quickly. B. BECKER. *Tonind.-Ztg.*, **66,** 55 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [1] 1A (1943).—B. claims that by the use of a new type of mechanical pug, a structure-free clay column can be obtained. The essential feature is the absence of the usual worm (apart from a short section near the entrance), so that the clot contains no banded structure caused by the screw blades and no air holes due to a thick hub. The column is prepared plastic and homogeneous through intensive pugging by means of inclined plungers or pistons in the barrel of the pug or by a "squeezing ring" in the pug. The clay is conveyed by this working process to the mouthpiece. Four types of pug designed on this principle are illustrated.

Measurement of the output of brick plants. H. LEITICH. *Tonind.-Ztg.*, **66,** 96 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [11] 122A (1942).—The output of a works depends on the capacity and the degree of efficiency. The measurement of internal, operational, regional, and uniform outputs and the definition of the basic capacity and yearly output are discussed; the dependence of the output on the type of product is considered.

Measurement of the thermal conductivity of materials used in building construction. E. GRIFFITHS. *Jour. Inst. Heating & Ventilating Engrs.* [London], **10,** 105 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [3] 21A (1943).—Four types of conductivity apparatus are described, and the data obtained on a number of building materials are tabulated. The materials of test included Fletton brick (including effect of porosity and of soaking), hollow glass blocks, diatomite (dry and soaked), cork, slag wool, glass silk, ebonite, concrete, mortar, and plaster. Figures are

* From microfilm.

also included for transmission coefficients from various surfaces. See "Some . . .," *Ceram. Abs.*, **24** [2] 43 (1945).

New method of transporting brick. C. SCHMIDT. *Tonind.-Ztg.*, **66,** 71 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [11] 122A (1942).—A new design of grab with prongs at the bottom which engage in hollow blocks at the base of the stack of brick is illustrated. The grab can deal with the usual stock-pile height of 16 courses and has a low loading height of 18 in. for transport by road. The top course is level, and the lowest layer is very stable. Loading can be carried out between walls of limited loading space. Jamming is avoided as also are movable parts. Wooden support platforms and gaps in the stock pile are eliminated. The grab can be used simultaneously for overcoming differences in height and for altering the loading height. Ordinary trucks can be used, and the grab affords suitable transport between railway cars, ships, trucks, and warehouses.

Postwar building techniques: II, Materials. ANON. *Architectural Forum*, **82** [2] 139–46 (1945).—Significant improvements in all types of building materials and evaluations of their possibilities are reviewed. In the masonry category, the noted development is the simplification of sizes and the modular unit of 4 in. incorporated in brick, structural tile, glazed and unglazed facing tile, cinder blocks, and concrete blocks. An outstanding structural improvement is the air-entrainment system in cement to eliminate freezing and thawing difficulties. Reinforced brick will be used more extensively. In the insulation group, Thermopane with its core of dehydrated air surrounded by two or more panes of glass presages the use of larger glassed spaces in future constructions. The Foamglas insulation, which uses true glass blown up and cellulated to provide five million tiny sealed air pockets per cu. ft., weighs only as much as cork and is waterproof and fireproof; it is produced in 12- x 18-in. rigid slabs of various thicknesses. Illustrated. M.E.P.

Revision of DIN 105: German Standard for building brick. G. PFISTER. *Tonind.-Ztg.*, **66,** 70 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [11] 126A (1942).—The revised German Standard for building brick is discussed by an architect. The necessity for size standardization is universally acknowledged, but the 25- x 12-cm. size has certain disadvantages. In the revised standard the water-absorption limit has been increased from 8 to 12%, since many brick of above 8% absorption have crushing strength and frost resistance equal to the specification.

Standardizing the agricultural pipe. ANON. *Brit. Clayworker*, **51** [604] 54 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [9] 108A (1942).—The advantages of standardization are enumerated.

Vertical pug—lamination in the brick. H. SCHMIDT. *Tonind.-Ztg.*, **65,** 423 (1941); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [8] 94A (1942).—The vertical pug with two mouthpieces produces clean-edged brick free from lamination. The material is broken up before entering the mouthpieces and passes through them horizontally. Operation is continuous, the clay being fed by a box feeder. The pug is operated by two hand cutters and two men for taking off the brick. A cylinder diameter of 3 to 4 ft. is favored.

SEPARATE PUBLICATION

First Report of the Committee on the Brick Industry. MINISTRY OF WORKS AND BUILDINGS. H. M. Stationery Office, 1942; abstracted in *Trans. Brit. Ceram. Soc.*, **41** [7] 87A (1942).—After a brief review of the structure and organization of the building-brick industry, the types of brick are classified and production data are tabulated. Labor and its relation to output also receive attention; this subject is related to the release of manpower, the closure of works, etc. **Second Report.** Abstracted in *ibid.*, [9] 108A.—A survey of the building-brick industry leads to the following recommendations: (*a*) a reduction in output by the closure of specific brickworks, (*b*) a quota system, (*c*) controlled prices, (*d*) compensation for loss of sales, and (*e*) the setting up of a National Building Brick Council.

PATENTS

Manufacture of acidproof brickwork. A. F. ZENNSTRÖM. Swed. 106,671; abstracted in *Chem. Zentr.*, **1943, II** [19] 1747.—Fillers of litharge-containing substances made up with water glass are used. The water glass should be neither pure Na nor pure K water glass but a mixture of both in the ratio of about 1:1. M.HA.

Tile flooring. NICK MARINO. U. S. 2,371,058, March 6, 1945 (Aug. 17, 1942). 1 claim. (Cl. 72-68).—A hollow building tile of the type adapted to be strung on wires and composed of ceramic material, the tile having flat parallel tread and ceiling faces and oppositely inclined generally flat side faces tapering from the ceiling face inwardly toward the tread face of the tile, each of the side faces being provided with a plurality of wedge-shaped recesses extending lengthwise of the tile, the top wall of each recess being disposed substantially parallel to the tread and ceiling faces and the other side wall of the recess tapering in the same direction as the corresponding side face but at a steeper inclination so as to intersect the side face, the top walls of one pair of the recesses on opposite sides of the tile being located approximately midway of the thickness of the tile and the recesses being of a size sufficient to laterally receive a supporting wire therein, and webs extending perpendicular and parallel to the tread face for interiorly strengthening the tile, the tread face and one of the webs joining the top walls of corresponding recesses located upon opposite sides of the tile.

Refractories

Acid electric furnaces and steel (foundry problems). Report of the Second Electric Furnace Steel Conference, A.I.M.M.E., Pittsburgh, Pa., Oct., 1944. ANON. *Metal Progress*, **46** [5] 1086–89 (1944).—By following such precautionary measures as (1) careful handling of brick, (2) use of proper forms for construction of the arches, (3) thorough packing with ganister between skewback and ring, and (4) slow drying and preheating of roof (60 hr. to reach 1000°F.), the roof life may be increased materially with resultant decreases in refractory costs and increases in furnace tonnage. Sillimanite (65% Al_2O_3) and basic brick offer promise for this service. B.C.R.

Basic brick in open-hearth construction. H. M. GRIFFITH. *Blast Furnace & Steel Plant*, **33** [1] 104–106 (1945).—All-basic construction on one end of a 50-ton furnace was in good shape after 750 heats. The slag was granular and easily raked out, thus preventing gradual blocking of the fantails. A 180-ton furnace was also converted to all-basic construction except for the roof. Costs for removing slag were 7¢ per cu. ft. during a shutdown and 9¢ during operation. Analysis of the slag showed it to be suitable for use in the blast furnace. The amount of dust found in flues and checker chambers was less than half that usually found in silica furnaces, and time down for repairs was 80 hr. instead of a probable 170 hr. A total saving of $16,500 is estimated. See *Ceram. Abs.*, **24** [3] 55 (1945). B.L.

Basic open-hearth process today: I. W. GEARY. *Metallurgia*, **26,** 123 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [10] 117A (1942).—Refractories usage in the roof, walls, ports, and regenerators is briefly discussed. **II.** *Metallurgia*, **26,** 175 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [11] 127A (1942).—The paper includes experience on the installation and maintenance of basic hearths in steel furnaces. A bottom installed in 1937 is illustrated. The firebrick lining of the pan is shaped roughly to the final contour of the hearth, and magnesite brick is then added. The magnesite has a minimum thickness of 9 in., with a panel 8 ft. square and 12 in. thick at the taphole. The working hearth is of dolomite fritted in with a little mill scale. The monolith

is of a fairly uniform thickness. A bottom construction designed to reduce the possibility of boils and to lower installation costs has a subhearth formed roughly to the lines of the finished bottom with a drop of 6 in. from the ends to the taphole and 2 in. from front to back. The hearth consists of 3 in. of insulation, 12.5 in. of firebrick cut to contour, a 9-in. soldier course of chrome-magnesite brick, and a 2-in. working hearth of fused grain magnesite. The need for insulation is not so great when the working hearth is made of dolomite. The use of plastic chrome or chrome-magnesite pastes is noted. These are water-setting and are rammed on the brickwork, leaving only a thin layer of magnesite to be burned on. These pastes are claimed to be cheap to install and extremely resistant to penetration by metal or slag. Crespi hearths are mentioned, and hearth maintenance is discussed, including fettling practice. **III and IV.** *Metallurgia*, **27,** 23, 77 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [2] 13A (1943).—Factors governing ladle life are briefly reviewed. Of interest is the report from America that careful reduction of the thickness of the lining in those places where least wear takes place increases the ladle capacity by about 15 tons and increases the life from 9 to over 13 heats. For many classes of top-poured steel a larger nozzle is advocated; such practice is favored in America.

Bauxite and aluminous laterite occurrences in Jashpur State, Eastern States Agency. A. K. Dey. *Records Geol. Survey India*, **75,** Professional Paper No. 16 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [4] 25A (1943).—Analyses are given of the bauxites of Jashpur; most of these contain 10 to 12% TiO_2. The most accessible is 80 miles from a railway.

Bayer process red mud treated for alumina recovery. Anon. *Chem. & Met. Eng.*, **52** [1] 106-107 (1945).—The Bayer process is used exclusively in this country for extracting alumina from clays and bauxite. Low-silica bauxites are essential, as each pound of SiO_2 carries one pound each of alumina, soda ash, and lime into the rejected red mud. Even with high-grade bauxites from Dutch Guiana, a recovery of 80 to 85% alumina is obtained. Treatment of the red mud with additional soda ash and coarsely ground limestone, ball milling, sintering at 1800° to 2000°F., and further ball milling after the addition of water to leach out soluble sodium aluminate, which is separated from the solids with large Oliver drum filters, provide an over-all recovery of 95% even with the use of low-grade bauxites. A flow diagram of the entire process is shown. The combination process is economical with bauxites ranging from 7 to 15% SiO_2. B.C.R.

Beryllium oxide as a refractory. Anon. *Elec. Times*, June 11, 1942; abstracted in *Trans. Brit. Ceram. Soc.*, **41** [8] 99A (1942).—Attention is drawn to the high electrical resistivity of beryllia. It is used in vacuum tubes and other electrical apparatus. Beryllia has been used for protecting Mo resistors in electric furnaces. See *Ceram. Abs.*, **23** [10] 170 (1944).

Carbon deposition in coke-oven roofs. G. E. Foxwell. *Coke Smokeless-Fuel Age*, **4,** 151 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [2] 13A (1943).—The carbon-forming reactions of ethylene, ethane, acetylene, and aromatic hydrocarbons are considered; to avoid carbon deposition, a well-operated oven should not have a free space temperature above 800°C. See "Coke . . .," *Ceram. Abs.*, **22** [5] 69 (1943).

Cupola practice. Anon. *Engr. Foundryman* [Johannesburg], June (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [9] 109A (1942).—Report of a general discussion on cupola linings, the use of ganister, handmade vs. machine-made brick, and taphole construction.

Development of Cowper stove insulation. F. Köhler. *Tonind.-Ztg.*, **66,** 111 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [2] 13A (1943).—After enumerating the advantages of insulating hot-blast stoves, K. discusses the difficulties encountered in the use of insulating powders and brick. Insulating materials in granular or powder form tend to settle slowly in use and may eventually damage the casing; they are also easily blown out by escaping gases as cracks form in the brickwork. Insulating brick may be crushed by pressure of the expanding brickwork, and the crumbled mass may again settle. A new insulating material (Ger. Pat. No. 691,922) is claimed to have none of these faults. It consists of graded calcined diatomite mixed with water-free tar. The material is warmed to 60° to 100°C. before use and is tamped into position in layers. As the brickwork is heated, the tar softens and the mass becomes plastic and is able to yield to the expanding brickwork. The space between wall and casing is thus completely filled. Subsequently, a slow distillation of the volatile matter takes place, leaving a compact mass of insulating grains bonded with coked tar. In this condition the material can neither settle nor be blown out. It is recommended for insulating Cowper stoves, blast pipes, mixers, acid converters, etc.

Development of a sulfuric acid process for production of alumina from clay. J. H. Walthall, Philip Miller, and M. M. Striplin, Jr. Presented at meeting of American Institute of Chemical Engineers, St. Louis; abstracted in *Chem. & Met. Eng.*, **52** [1] 105 (1945). B.C.R.

German standards for refractory materials: ramming materials and cements. Anon. *Tonind.-Ztg.*, **66,** 73 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [11] 131A (1942).—Tests are described for the determination of the mechanical analysis and the firing shrinkage (or expansion) of refractory cements and ramming materials. The mechanical analysis is tested by sieves down to 0.06 mm. and by elutriation for the finest fractions. The firing shrinkage is determined by molding a cylinder 50 mm. in diameter and 45 mm. high and determining its volume before and after firing; a mercury- or water-displacement method is used, the test piece being first coated with wax.

Graphite in industry. Anon. *Chem. Trade Jour.*, **111,** 503 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [2] 9A (1943).—Unusually large and tough crystalline flake graphite occurs in Madagascar; it is used in crucibles. Vein graphite (90% C) and dust graphite (55 to 80% C) are produced in Ceylon. Good quality amorphous graphite occurs as beds in sandstone in Mexico and Korea. Approximately 30% of the total graphite output is used in foundries.

Increasing the life of silica brick made from Bobrovsk quartzites in the roofs of open-hearth furnaces. V. D. Tsigler. *Ogneupory*, **1941,** No. 9, pp. 9-13 (1941); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [8] 100A (1942).—Lime-bonded roof brick manufactured from these quartzites failed by spalling, since penetration of Fe oxides was insufficient to bring about fusion into a monolithic structure. The addition of ferruginous mineralizers brought about an appreciable increase in life; 1% mill scale was more effective than 1.5% blast-furnace dust. Loosening of the larger grains during service was eliminated by finer grinding of the batch, the maximum grain size being reduced to 5 mm.

Investigation of the properties of corundum brick with special reference to their thermal conductivity. H. Lasch. *Tonind.-Ztg.*, **66,** 89 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [1] 6A (1943).—Three kinds of corundum brick of known constitution and with increasing Al_2O_3 content were investigated with regard to chemical composition, refractoriness under load, true and apparent specific gravity, porosity, reversible thermal expansion, and spalling resistance. The thermal conductivity was investigated by a method in which the heat flow is stationary. No definite conclusions on the constitution of corundum brick can be drawn from the chemical analysis alone. The SiO_2 content does not always come from admixed grog and ball clay; it can also be traced to the use of impure corundum. The refractoriness under load of the corundum brick does not depend only on the corundum content; it is influenced by the grading and the process of manufacture. The high spalling resistance of the corundum brick investigated is emphasized. The thermal-conductivity investigations have shown that brick with up to about 50% corundum have a conductivity at a medium temperature equal to that of firebrick of normal porosity. With brick containing up to 50% corundum, the conductivity increases slightly or remains constant up to about

650°. At higher temperatures, the conductivity decreases slightly, which is explicable by the corundum content. Brick with high corundum content (80%) show a comparatively rapid decrease in conductivity with increasing temperature, since they are crystalline.

Magnesium from sea water. GERALD E. STEDMAN. *Metals & Alloys*, **20** [4] 941–48 (1944).—The Dow Chemical Co. method of producing Mg from sea water at its Texas Gulf plants is described. B.C.R.

Malleable beryllium. G. E. CLAUSSEN AND J. W. SKEHAN. *Metals and Alloys*, **15** [4] 599–603 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [8] 101A (1942).—Beryllium can be melted without contamination in beryllia or graphite crucibles; zirconia crucibles are attacked. A method of producing small beryllia crucibles is described.

Manufacture of firebrick in South Australia. ANON. *Chem. Eng. Mining Rev.*, **37** [435] 78 (1944).—An investigation of clays in South Australia is contemplated in an effort to manufacture high-grade firebrick and ceramic ware from domestic materials. B.C.R.

Molding high-duty metallurgical and complicated coke-oven silica brick by the method of high-frequency vibration. G. V. KUKOLEV, A. T. ZELENSKAYA, AND Z. P. SHALOMEEV. *Ogneupory*, **1937,** No. 8, pp. 510–24; abstracted in *Trans. Brit. Ceram. Soc.*, **42** [4] 26A (1943).—An account is given of developmental work on the vibration method of molding, initiated by the Institute of Refractories, Kharkov. Trials are described in which a full-scale experimental vibration machine was employed. The final version of the vibration method of molding, applied as a production process, retains the original sequence of operations and the pressing and vibration devices. See "Shaping . . .," *Ceram. Abs.*, **19** [1] 16 (1940).

Note on arc furnace refining slags. N. F. DUFTY. *Metal Treatment*, **8,** Spring Issue, 17 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [9] 109A (1942).—Discussing the effect on the refractory lining of the fluorspar added to the slag, D. considers that the fluorspar decomposes, the liberated F attacking the silica lining to form SiF_4.

Pressing silica brick. W. HUPPE. *Tonind.-Ztg.*, **66,** 179 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [3] 17A (1943).—The advantages and field of application of the revolving-table press, power-driven screw press, and eccentric, toggle, and hydraulic presses are briefly discussed. For the small works embarking on machine pressing for the first time, the power-driven screw press is probably the most suitable because of its low initial cost, adaptability, and ease of installation and maintenance.

Production of frothed grogged heat-insulating materials at the Podol Works. A. A. PIROGOV AND L. R. BILSON. *Ogneupory*, **1938,** No. 7, pp. 1286–97; abstracted in *Trans. Brit. Ceram. Soc.*, **42** [4] 30A (1943).—The manufacture of insulating brick by mixing prepared foam with a highly grogged slip is applied to full-scale production. Laboratory work forms the first part of the paper. The works trials investigate the following factors: (*a*) the proportion of the clay bond, (*b*) type of clay, (*c*) grog grading, (*d*) action of acid or gypsum in stabilizing the foam, and (*e*) the use of porous grog. The manufacture of blocks up to 14-in. cube is described; special attention is paid to drying problems. Data on density of foam-slip mixtures, effect of sawdust addition, drying and firing shrinkage, and the properties of the fired brick are presented. The trials culminated in the production of a batch of 500 brick.

Production in rotary furnaces of steel for castings. F. A. LEMON AND HUGH O'NEILL, with appendices by T. FLETCHER AND J. N. BRADLEY. *Jour. Iron & Steel Inst.* [London], **146** [2] 53–72P (1942).—The manufacture of plain carbon steel in 5-ton Sesci rotary furnaces is described. The furnaces use monolithic acid refractory linings of British origin and are fired with pulverized coal. Great difficulties were encountered in securing a good life from the refractory linings. With intermittent working this has been raised from a beginning of 29 heats per lining to an average of 125, with a record value of 226. A daily patching technique, developed to enable improved life to be obtained, is described. Chemical, physical, and petrographic data of patch and various lining materials are given. The most useful lining is one with adequate refractoriness and low afterexpansion but, above all, a facility for forming a durable ceramic bond with the patch repair. 20 references, 9 figures.

Ramming materials for cupolas. F. NAUMANN. *Giessereipraxis*, **62,** 49 (1941); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [8] 100A (1942).—Ramming materials for cupola linings are being used because such linings are cheaper and, above all, are not jointed. The ramming material, which is made of quartz sand, quartzite, and refractory clays, should show a refractoriness of cone 33 to 34 (1730° to 1750°C.) and should contain approximately 88 to 95% SiO_2 and 5 to 8% Al_2O_3. The life of the ramming material depends on the composition of the charge. Investigations have shown that charges containing 85% scrap, as compared with 25% scrap addition, shorten the life of the furnace lining to about 60%. The ramming material should be delivered to the works dry. Preparation must take place with the amount of water specified.

Reaction between copper reverberatory slag and refractories. SAHAP S. KOCATOPCU. *Jour. Amer. Ceram. Soc.*, **28** [3] 65–71 (1945).—17 references, 12 figures.

Recrystallized alumina products. B. MOORE. *Ind. Chemist*, **18,** 467 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [2] 13A (1943).—For slipcasting alumina ware, a clean slip of alumina in dilute HCl is used. Firing must be done at $\lesssim$ 1600°C. See *Ceram. Abs.*, **22** [3] 55 (1943).

Refractories in 1944. LOUIS A. SMITH. *Blast Furnace & Steel Plant*, **33** [1] 114–15 (1945).—Developments of the year include an increased use of low-alumina brick and of cold rammed bottoms and early trials of the all-basic furnace. B.L.

Refractory lining for rotary cement kilns: I. W. F. ROCHOW. *Rock Products*, **48** [1] 188, 190, 192, 232, 234 (1945).—Many variables in rotary cement kiln operation preclude the possibility of predicting the service secured from the refractory linings based on analogy alone. Such variables include clinker composition, sintering or clinkering temperature, lack of uniformity in chemical composition of feed, irregularity of feed, ring formation, intermittent operation, reducing atmosphere, distorted shell, and installation of lining. Factors involved in the selection of the proper refractory for the feed end, intermediate zone, high-temperature zone, and discharge end are discussed. Among the basic lining materials, chemically bonded magnesite brick laid with steel sheets is used most extensively. Proper design of the nose and tail blocks is important to avoid trouble and costly maintenance. B.C.R.

Service of open-hearth furnace hearths of the Azovstal works. I. SHVARTSMAN. *Ogneupory*, **1941,** No. 1, pp. 24–28; abstracted in *Trans. Brit. Ceram. Soc.*, **41** [8] 99A (1942).—Preliminary experiments showed that the composition and structure of the hearth have less influence on its life than the conditions of service during the initial period. In building up the hearth layer by layer it is necessary to add sufficient slag to the magnesite so that the "index of basicity," (CaO + MgO)/SiO_2, increases by degrees from the first layer upward. The amount of slag to be added to each layer can be calculated by means of the formula $x = \frac{a_1 - tb_1}{a_1 - a_2 + t(b_2 + b_1)} \times 100$, where x = slag addition (%), a_1 = total MgO + CaO in the magnesite (%), a_2 = total MgO + CaO in the slag (%), b_1 = % SiO_2 in the magnesite, b_2 = % SiO_2 in the slag, and t = index of basicity. Recommended values for the index of basicity increase from 12 in the first layer to 19 in the twelfth layer.

Some refractory materials in northeastern England. R. G. CARRUTHERS AND W. ANDERSON. *Geol. Survey Gt. Brit. Wartime Pamphlet*, No. 31 (Jan., 1943); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [4] 25A (1943).—The pencil ganister and quartzite sandstone of northeastern England are described. Many of the outcrops of the former have been worked out. Quartzite sandstone of high purity occurs in the Millstone Grit and Upper Limestone of Weardale and Tynedale; these beds sometimes attain a thickness of 30 ft. The Hearthope rock

contains over 97% SiO_2, has a refractoriness of 1710°C., and remains compact on firing in a silica-brick kiln. Other rock which might be suitable for making silica brick occurs at Linn Shield and Park, in the vicinity of Haltwhistle. The distribution and suitability for use as molding sands of the rotted grits (Millstone Grit) and yellow sands (Permean) of northeastern England are discussed. The grain size, permeability, and strength of these sands were determined, and the Durham yellow sands were analyzed. The Aid Crag silica sand is considered suitable as a hearth sand.

Studies on coking pressure. W. Fuchs and A. G. Sandhoff. *Fuel*, **21**, 70 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [9] 109A (1942).—Some factors influencing the pressure on coke-oven walls are discussed.

PATENTS

Apparatus for making plug brick. J. B. Blewett (McLain Fire Brick Co.). U. S. 2,369,102, Feb. 6, 1945 (July 22, 1943). 7 claims. (Cl. 25-44).

Attachment for making plug brick. J. B. Blewett (McLain Fire Brick Co.). U. S. 2,369,101, Feb. 6, 1945 (July 22, 1943). 8 claims. (Cl. 25-44).

Furnace wall. W. G. Young (Chicago Fire Brick Co.). U. S. 2,369,100, Feb. 6, 1945 (July 17, 1943). 9 claims. (Cl. 72-101).

Heat-resistant ceramic material. Robert Bosch G.m.b.H. Belg. 444,977; abstracted in *Chem. Zentr.*, **1943, II** [25] 2258.—The material consists of an alumina melted in the electric arc at 2000°C. or higher and then quickly cooled and ground. M.Ha.

Manufacture of highly refractory brick. "Brohltal" A.-G. für Stein- und Tonindustrie. Belg. 445,017; abstracted in *Chem. Zentr.*, **1943, II** [25] 2258.—The brick are made of a weakly burned magnesite with other additions. The original mixture is 66 to 85 MgO, 10 to 30 Fe_2O_3, 1 Al_2O_3, 1 SiO_2, and 2% CaO; the brick formed from this mass are fired at 1460° to 1500°C. M.Ha.

Terra Cotta

Hints on roof-tile manufacture. Anon. *Brit. Clayworker*, **51**, 73 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [11] 123A (1942).—Two methods of hand molding are described. To manufacture wire-cut plain tile, a die is attached to the pug-mill mouthpieces of the requisite form and dimensions to ensure the extrusion of a continuous column of the shape of a plain tile with a continuous nib along one end. In some works elaborate machinery is installed in which the clay, after thorough preparation, is run out onto a cutting table by means of a pair of "expression" rollers. The clay column produced is stiff enough for pressing direct, and a length is cut off such that it is rather smaller than the press mold. The lengths so cut off are "bats" containing the exact amount of clay required for the finished pressed tile. Tile fittings are detailed, and a description is given of tile hanging, the pantile, the Courtrai tile, and handmade paving tile.

Whiteware

American ceramics. Ross C. Purdy. *West Va. Univ. Bull.*, Ser. 45, No. 3-II, 59–63 (Sept., 1944).—American ceramic ware is inferior to none and superior to most.

Corner lavatory. Anon. *Architectural Forum*, **82** [2] 97–100 (1945).—Based on the premise that every room has four corners, the "corner lavatory" designed by George Kosmak, Ruth Gerth & Associates, provides a satisfactory adjunct to crowded living quarters or a supplement to the modern streamlined bath. A well-organized compact plan allows the maximum amount of equipment without crowding. Illustrated. M.E.P.

Electrical properties of high-frequency ceramics. E. Rosenthal. *Electronic Eng.*, **14**, 388, 438 (1941); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [3] 22A (1943).—Bodies composed of clinoenstatite, rutile, cordierite, and $2MgO \cdot TiO_2$ are considered. Clinoenstatite is considered an improvement on the steatite body; the dielectric properties improve as crystallization advances. This type of body is readily molded. Rutile has a very high dielectric constant, but this is decreased by the clay which must be added to give plasticity. Both rutile and $2MgO \cdot TiO_2$ can be made only into comparatively simple shapes. Cordierite has a higher power factor but is valuable if a small thermal expansion is required. Data on the power factor, dielectric constant, temperature coefficient of capacitance, and thermal expansion are given for each type of body. The significance of these constants in the design of condensers, coil formers, etc., is considered. By the use of burned-on metal coatings, coil formers can be produced having an inductance practically independent of the temperature.

Frustrated potters. Robert P. Brundage. *Wall Street Jour.*, **125** [28] 1 (Feb. 2, 1945).—The war has brought to the U. S. pottery industry the greatest demand in history at the same time that shortages of labor, fuel, materials, and machinery are acute. Foreign competition has held U. S. production to about 70% of the amount used in the domestic market, and potters are afraid to expand capacity above that point during the war emergency. B. says that colors came into extensive use about ten years ago and have helped to increase the market for American products. Eighty per cent of the domestic production is made in 32 plants, half of this within a radius of 200 miles of East Liverpool, Ohio. That fine china is made in America is illustrated by the list of potteries given which are producing such ware. These companies are studying methods of promoting U. S. ware after the war. C.S.P.

Influence of variable amounts of New York talc, flint, and calcined clay on serviceability of glazed cooking-ware bodies. Forrest Burnham and Milton A. Tuttle. *Jour. Amer. Ceram. Soc.*, **28** [3] 72–75 (1945).—2 figures.

SEPARATE PUBLICATION

Study of the Flow Properties of Concentrated Clay-Water Mixtures. W. J. Smothers and Paul G. Herold. *School Mines Met., Univ. Missouri, Bull., Tech. Ser.*, **15** [3] 103 pp. (1944).—The flow properties of three commercial kaolins (Florida, North Carolina, and Georgia) were examined by forcing them through orifices rather than capillary openings under pressures of 0 to 100 lb. per sq. in. Orifices of differing length and diameter were used, the one adopted being 2 in. long and 0.125 in. in diameter. The effects of water content, added NaOH after electrodialysis, and particle size on flow properties were studied. An equation was developed relating water content to starting pressure. Three factors were indicative of the workability of the different mixtures: the pressure at which flow began, the relative rate of change of flow with pressure after flow had begun, and the flow value at which a reversal in curvature in the flow curve was noted. The portion of the flow curve below the reversal could be fitted to an exponential type of equation. P.G.H.

PATENTS

Electrically conductive ceramic thread guide. Hans Thurnauer (American Lava Corp.). U. S. 2,369,266, Feb. 13, 1945 (Jan. 28, 1941). 6 claims. (Cl. 242-157).—1. A ceramic thread-guide body comprising a vitrified mixture of titanium oxide and a metallic oxide, the vitrified body having a resistivity not greater than 1 megohm per $cm.^3$.

Insulators for high-tension electrical transmission systems. C. H. W. CLARK AND STEATITE & PORCELAIN PRODUCTS, LTD. Brit. 566,871, Jan. 31, 1945 (May 12, 1943).

Method and apparatus for manufacturing pottery ware. W. J. MILLER. U. S. 2,370,410, Feb. 27, 1945 (Feb. 21, 1940). 21 claims. (Cl. 25-22).

Shielded spark plug. E. O. SETTERBLADE (Wright Aeronautical Corp.). U. S. 2,368,889, Feb. 6, 1945 (Oct. 10, 1941). 9 claims. (Cl. 123-169).

Equipment and Apparatus

Applications of unit operations and processes in the ceramic industries. W. A. KOEHLER. *Trans. Amer. Inst. Chem. Engrs.*, **40** [5] 575–92 (Oct., 1944).—Unit operations and processes are discussed. Power and fuel requirements and capacities are given in most cases, and some special problems and their solutions are discussed briefly. (1) Crushing and grinding. Nearly all ceramic raw materials require the use of reduction equipment. The types discussed include jaw, gyratory, and roll crushers, pulverizers, dry and wet pans, ball and tube mills, and burrstone mills. Mention is made of the special problems encountered in the crushing of shales and hard clays, particularly when wet. The use of heated crusher surfaces is a possible solution. A new development in dry pans is the use of lightweight mullers in combination with air cylinders, thus providing a variable pressure range of 3 to 9 tons. A reduction of muller pressure in handling damp and soft materials resulted in an increased capacity. (2) Mixing and blending. The various types of pug mills, together with blungers, are described. (3) Screening and separating. K. deals with the various types of screening equipment, including the piano-wire screen, revolving screen, and shaking and vibrating screens of the Hummer type; equipment for magnetic and electrostatic separation; and methods and equipment for dewatering clays such as filter presses, electrophoresis, and settling. Induction magnetic separation is a relatively new development and is based on the fact that the freely falling particles may be more easily diverted from their path than directly lifted against gravity as in the usual magnetic separator. This method is finding application in the separation of materials of such low magnetic properties that they have been considered nonmagnetic for all practical purposes. It is widely used in the abrasives industry and is gradually being extended to other ceramic materials. Electrostatic separators are used in cement-dust and glaze recovery; the separation of mica from graphite, copper pyrites from zinc blende, and quartz from kyanite; and in feldspar purification. The filter press removes excess water from clay and body mix. Maximum pressures of 80 to 120 lb. per sq. in., capacities of 2000 lb. of clay per hour, and cake moisture of 20 to 24% are common operational characteristics. The Oliver-type filter is finding increasing application, but its use still constitutes an exception to general practice. Electrophoretic methods of dewatering clay suspensions depend upon the fact that in such suspensions the clay particles are negatively charged and the water is positively charged. Thus, by impressing a suitable voltage, the clay particles can be made to migrate to the positively charged electrode. This method is also used in the lubrication of extrusion dies. The only plants generally employing this method before the war were in Germany and Czechoslovakia. Water settling is used for washing clays and sands to remove sand, mica, and coarse minerals, thus producing a pure clay slip. (4) Weathering and aging. Disintegration of clay particles is advantageously produced by winter-long exposure above ground to the physical and chemical action of the elements. The necessary large storage space, tie-up of capital, and extra handling costs constitute objections to this method. Pyrites in clay on weathering form soluble sulfates, causing scumming; weathering should be continued until the soluble sulfate is leached out of the clay. Aging improves the plasticity and working properties of tempered and pugged clays which are stored indoors for various periods depending upon the nature of the clay and the ware to be made. Deairing machines, however, accomplish the same purpose in a very short time. (5) Forming and shaping. Due to the plastic properties of clays, various means can be employed for shaping and forming the articles. (*A*) Soft-mud process. For brick manufacture, the clay is first put through a disintegrator if it is lumpy, and then the proper amount of water is added in a pug mill to produce a finished brick that will just hold its shape but will deform if jarred or shocked. In firebrick plants, the molding is commonly done by hand; for common- and face-brick manufacture, machines are used. A modern machine containing six molds produces 3000 to 5000 brick per hour and requires 20 to 30 h.p. Soft-process brick are not laminated and may be cut or broken along any desired line. (*B*) Stiff-mud process. Plastic clay is extruded through a die and emerges as a column, which is cut into required lengths to make common and building brick, firebrick, building tile, drain tile, and sewer pipe. A typical process requires crushing, dry-pan grinding, and pug milling, followed by extrusion through a suitable die. One disadvantage is the formation of laminations; the use of deairing machines, however, has helped to reduce the difficulties due to lamination. A large machine produces 15,000 common brick per hour and requires approximately 75 h.p. The stiff-mud process is also used for making dinnerware and artware. (*C*) Dry-press process. A damp powder is used, enough water (usually 7 to 12%) being present so that the clay can be balled. A dry-press machine molds the clay at a pressure above 10,000 lb. per sq. in.; excessive pressure, however, causes cracking. This difficulty can be overcome by deairing or by replacing the air in the mixer with condensable gases such as ammonia or propane. A six-mold, 25-h.p. machine produces up to 3600 brick per hour. Repressing in both the stiff-mud and soft-mud processes is used to yield exact dimensions and also to produce special architectural shapes. Casting employs fluid clay-water mixtures which are poured into plaster-of-Paris molds. The mold absorbs water from the slip to form a dense layer. After a time the excess slip is poured off, leaving the dewatered layer in the mold. Both organic and inorganic deflocculants are employed to increase fluidity, thus allowing the use of more concentrated slips of up to 70% clay. This process is used to manufacture irregular shapes. (6) Drying. Sand and bulk clay present no drying difficulties, rotary direct-fired driers 4 to 5 ft. in diameter and 20 to 60 ft. long being used. Specially molded clayware, however, presents special difficulties because of the danger of cracks being started by strains due to shrinkage. The drying of clayware falls into three main stages: (*a*) preheating stage at 80 to 90% relative humidity to bring the clay to drying temperature; this step is necessarily slow because of the low heat conductivity of clay; (*b*) shrinkage stage, in which the humidity of the drying air is lowered to permit evaporation; close control is essential so that the rate of evaporation from the surface will not exceed the rate of diffusion; (*c*) the pore-water stage, in which the humidity is again lowered and the temperature raised to complete the drying operation. A stiff-mud brick will require over 2500 B.t.u. for complete drying. Commercial methods used for drying ware are as follows: (*A*) Hot floors. The hot floor is heated by steam pipes imbedded in a concrete floor, exhaust or live steam being used. Although difficult to control, inefficient, expensive to construct, and wasteful of space, they find extended use in heavy-ware manufacture. (*B*) Waste heat progressive driers. This type of drier consists of multiple tunnels side by side, each tunnel having a single track filled with loaded cars. The heat is taken from the kilns that are cooling, thus providing economic operation and speeding the kiln cooling. Auxiliary heat from furnaces or kilns on fire is to be avoided, since the presence of combustion products of

sulfur will cause scumming. The driers are usually 110 ft. long and hold 15 cars. The drying air passes on a countercurrent principle, the coolet, more humid air meeting the freshly charged ware and providing the necessary slow drying. This type of drier is built for the utilization of waste heat from many sources and is sometimes used in connection with car tunnel kilns. It is used in a majority of structural clay plants. (*C*) Radiated heat driers. This type is constructed similarly to the waste-heat drier, but the car tunnels have furnaces below them at one end and smoke flues running along under the tracks. The air for drying enters through the furnace pit and circulates through the tunnel; on contacting the ware, it is cooled, settles to the floor, and is again heated by contact with the flues. Such a drier has a good average efficiency of about 80%. A new development in this type of drier is to pass the products of combustion from the kilns through the flues. (*D*) Driers with automatic humidity control. Two general types of driers, periodic and continuous, are used with automatic humidity control. The periodic type is initially furnished with air at a high humidity; this humidity is gradually decreased during the drying period with a resultant increase in the rate of drying. The continuous type is built on the car-tunnel principle, and the drier is divided into four sections along its length, in each of which is maintained automatically graduated conditions of humidity and temperature suited to the stage and period of drying. The more rapid drying by full automatic control greatly reduces hold-up of material in process and drying losses. (*E*) Mangles. These steam-heated chamber driers, used largely by the whiteware industry, are equipped with steam coils so placed that the ware, as it moves through the chamber, comes into contact first with a relatively low temperature and high humidity and later with a higher temperature and lower humidity. (*F*) High frequency electrostatic heating. By the use of high frequency alternating current, a distortion of each molecule of the ware can be brought about, first in one direction and then in the other, depending on the rapid reversal of voltage. This causes internal friction and produces heat in the object itself, thus eliminating the problem of heat transfer. Frequencies used vary from 1 to 10 mc. (7) Firing. The firing process is divided into several stages: (*a*) dehydration, up to approximately 600°C., during which mechanically and chemically combined water is removed; (*b*) oxidation of organic matter at about 300°C. with subsequent oxidation of sulfur and carbon, oxidation of ferrous to ferric iron, and calcination of calcium and magnesium carbonate up to about 900°C.; and (*c*) vitrification, during which some of the minerals melt and, on cooling, serve as a binder to the unmelted particles. For common clay this temperature range is between 950° and 1050°C. Kilns used for firing ceramic materials are as follows: (*A*) Scove kiln. This type is of a temporary nature; the brick to be fired are arranged so that fires may be kindled in openings left in the bottom, and the products of combustion pass through the brick. (*B*) Updraft periodic kiln. This kiln is circular and is constructed with furnaces located circumferentially around the lower part of the kiln. The products of combustion pass upward through the ware and out of the stack. The kilns are usually about 16 ft. in diameter. Due to inefficiency, this type of kiln is gradually being displaced. (*C*) Downdraft periodic kiln. This kiln is very similar to the updraft kiln, but baffles are arranged so that the products of combustion are deflected from the ceiling to the floor, where they pass through an opening into the stack. (*D*) Continuous kilns. Since periodic kilns utilize only about 8% of the heat liberated, more efficient types have been devised in which the hot waste products of combustion preheat the ware, while the air used for combustion is preheated by the hot fired ware. Such a kiln uses 300 to 500 lb. of coal per 1000 brick as compared with about 800 lb. of coal for a periodic kiln. (*E*) Car tunnel kiln. The ware is placed on cars that pass along a tunnel 200 to 500 ft. in length so heated that water-smoking, dehydration, and vitrification progress in the ware as the cars pass through the zones of corresponding temperature. (*F*) Circular tunnel kiln. This kiln is built in the form of an open circle with the entrance and discharge ends rather close together. A large horizontal ring, on which the ware is placed, turns slowly through the kiln. This type is adapted for firing all types of ware. (8) Conclusion. Only the major processes are discussed. Many others that on casual observation may seem simple have presented problems not easily solved. The ceramic industry has traditionally been based on art and personal skill, but science has made and is still making rapid forward strides, and the field has enlisted the help of numerous highly skilled and trained technologists and scientists. W.T.G.

Crystal photography with divergent X rays. K. Lonsdale. *Nature*, **151,** 52 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [3] 24A (1943).—Using a very low input tube which gives a beam of copper X radiation divergent externally through nearly 180°, accurate estimates of lattice distance can be made. From one or two photographs of a suitably shaped crystal, the unit cell and space group can be determined.

Device for use in making powder specimens for a high-temperature X-ray camera. H. Lipson and O. S. Edwards. *Jour. Sci. Instruments*, **19,** 186 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [3] 24A (1943).—A silica rod is sealed, in alignment, in a thin-walled silica tube; the manipulative technique is outlined.

Heating and operational problems in artificial drying. Anon. *Tonind.-Ztg.*, **65,** 567 (1941); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [8] 95A (1942).—The drying plant described is placed above the tunnel kilns; it consists of 28 chambers with a total theoretical capacity of 280,000 brick. The end chambers are not dried as quickly as the remainder. The synchronization of the presses, drier, and kiln is of first importance. Unless the steam can be exhausted from the drier quickly enough, the roof of the latter will deteriorate.

Infrared baking. H. Seymour. *Electrician*, **129,** 200 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [11] 124A (1942).—Lamp and reflector design are discussed. Radiant heating has the advantage over convection heating in that very high energy-transfer rates are obtained.

Infrared heating. Anon. *Electrician*, **132** [3425] 56–57 (Jan., 1944).—A short report is given on the practical application of infrared in drying paint and putty on airplane parts. Infrared does the job in approximately one-tenth the time required in steam drying. H.K.R.

Operational experiences with chamber drying plant. K. Spingler. *Tonind.-Ztg.*, **66,** 68 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [11] 124A (1942).—The drying time is dependent on the uniformity of the drying of the goods throughout the chamber. Variations in the supply and discharge of the air, the ingress of excess air, and bad setting of the goods are causes of irregular drying. Drying frames and pallets, the track equipment, and maintenance of the drier cars are dealt with.

Tractor-trucks haul 11-ton loads of asbestos up 24% grade. W. E. Trauffer. *Pit and Quarry*, **37** [8] 68–70 (1945).—In the Bell Asbestos Mines, Ltd., quarry at Thetford Mines, Quebec, changing conditions have brought about a hauling problem. The floor of the quarry is now 250 ft. below normal ground level. Eleven-ton capacity tractor-trucks are used for carrying out the asbestos-bearing rock, and T. describes the method of operating these trucks from quarry to plant. 8 photographs. M.R.

Tunnel drier. W. Schnell. *Tonind.-Ztg.*, **66,** 199 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [3] 18A (1943).—The tunnel drier is able to deal with tender clays at a much more rapid rate than the hot-floor or chamber drier. If run overnight with reduced heat input and stationary cars, as is normally the case, the drying zone may move back toward the charging end so that the first cars to enter next day may be dried too quickly. Unequal operating conditions in day and night working may also occasion wastage of heat or condensation on the ware. Full efficiency will not be attained until brick or tile production is organized on a 24-hr. basis. In planning the installation of a tunnel drier, it is not sufficient to calculate the heat required to evaporate the moisture from a planned

weight of goods. Heat is also consumed in heating the ware, cars, and supports and is lost by radiation and convection from the walls, roof, and floor. These losses can be computed approximately, and an example of such a calculation is given. The total heat requirements and necessary air supply are also calculated. The various sources from which the heat may be drawn are discussed.

Vitreosil filtering and ignition crucibles. ANON. *Chem. Eng. Mining Rev.*, **37** [433] 4 (1944).—Porous Vitreosil crucibles suitable for ignition up to 1000°C. are available in four grades of porosity, thus obviating the need of asbestos. B.C.R.

SEPARATE PUBLICATION

Norelco Electronic Products. ANON. Published by North American Philips Co., Inc., 100 East 42d St., New York 17, N. Y., 1945. 8 pp., 15 illustrations.—The subjects covered are as follows: (1) cathode-ray, transmitting, power, and amplifier tubes; (2) quartz crystal oscillator plates; (3) Searchray (X-ray) inspection units; (4) Geiger-counter X-ray spectrometer; (5) film-type X-ray diffraction equipment; (6) quartz crystal X-ray analysis unit; (7) metallurgical products (tungsten and molybdenum powder, rod, sheet, and wire; aluminum alloy, enameled copper, resistance, silver, and gold-clad silver wire in fine sizes); and (8) medical X-ray equipment (radiographic units, tables, tubes, tube stands, and miscellaneous accessories).

PATENTS

Apparatus for measuring the degree of roughness of a surface. KAPELLA, LTD., AND R. E. REASON. Brit. 566,-591, Jan. 17, 1945 (June 17, 1943).

Dust precipitator. W. R. APPELDOORN. U. S. 2,370,629, March 6, 1945 (June 2, 1943). 1 claim. (Cl. 183-80).

Machines for making brick, block, and like building elements. I. ORSINI. Brit. 566,919, Jan. 31, 1945 (Jan. 22, 1943).

Kilns, Furnaces, Fuels, and Combustion

Advancement in heat application to gas-fired furnaces. JAMES KNIVETON. *Ind. Gas*, **22** [12] 13–16, 38–39 (June, 1944).—A detailed description is given of the Selas radiant burner, and its application to the firing of various ceramic materials is noted. A rotary hearth circular kiln is illustrated. The application of these burners to a completely automatic installation for heat-treating armor is described. In this case 3500 radiant gas burners in the side walls are spaced and located for patterned distribution, which is one of the advantages of this type of construction. A description is given of the open application of gas burners in automatic machines for selective hardening and annealing. In this case a superheat type of burner is used, a gas mixture being burned inside a corrugated refractory wall forming the body of the burner combustion chamber. Temperatures higher than obtainable with gas in any other way are the result, and the distribution of the burned gases at a high velocity accelerates the heat transfer to the receiving body. The largest burner of this type has a heat-liberating capacity of 40,000,000 B.t.u. per hr. per cu. ft. of combustion space. H.K.R.

Annular or tunnel kiln in the brick industry? W. KOVATS. *Tonind.-Ztg.*, **65,** 623 (1941); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [8] 96A (1942).—On the basis of the output, capital cost, running costs (including fuel and labor), and quality of product, it is concluded that the tunnel kiln is generally preferable to the annular or zigzag kiln.

Elevated temperatures without preheated air. P. W. CRAIG. *Ind. Gas*, **23** [4] 13–15 (Oct., 1944).—Ceramic testing kilns located in the Hays Laboratory of the Harbison-Walker Refractories Co. are described and illustrated. To obtain a temperature of 3000° to 3200°F. in a furnace without preheating the combustion air, care must be taken to obtain the maximum combustion efficiency possible. Combustion efficiency is affected (1) by the excess air in the burner mixture and (2) by excess gas. Three charts are given which can be used to determine the proper conditions of excess air and gas to reach the temperatures given above. The necessity for accurate control is stated. With the use of a well-designed proportional mixer, inspirator set, or gas-mixing machine, nearly perfect air-gas ratios can be set by actual flue-gas determination under cold furnace conditions, and a high combustion efficiency is thus maintained. H.K.R.

Firing of common and blue brick. O. KRAUSE AND H. S. CHEN. *Tonind.-Ztg.*, **66,** 155 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [1] 3A (1943).—To investigate the influence of the temperature and time of firing and the kiln atmosphere on the structural alterations of heavy clay products, five brick clays containing different proportions of clay substance, feldspar, and iron oxide were heated in a specially developed furnace at temperatures between 750° and 1250°C.; the duration of firing was varied logarithmically, viz., 19, 60, 190, 600, and 1900 min.; for a firing period of 190 min., the kiln atmosphere was varied from strongly oxidizing to strongly reducing. The influence of the firing conditions was investigated by determinations of the alterations in specific gravity and the thermal expansion behavior of the fired test pieces. These determinations showed that a fluid melt phase may be formed (*a*) because of the liquefaction of the feldspar below its melting point through eutectic formation or (*b*) because of eutectic formation in the system $FeO–SiO_2$. Both processes, in which the melting away of feldspathic constituents can enter, are superimposed at the higher temperatures. From the thermal-expansion behavior it can be concluded that these eutectic melts, in the course of the firing process, dissolve the quartz contained in the brick clays; the degree of solution is dependent on temperature and time. With the blue-brick clays rich in iron oxide, the $FeO–SiO_2$ eutectic acts as a mineralizer in the quartz-cristobalite conversion. The atmosphere has an essential influence on this liquid melt phase and therefore on the quartz solution. The complex mineral composition and the peculiarity of the brick clays investigated preclude any more accurate explanation of the additional processes, e.g., the formation of aluminum silicates; it may be assumed, however, that the processes proceed in a manner similar to those in fine ceramic bodies. See *Ceram. Abs.*, **23** [5] 93 (1944).

Fuel-oil system. J. T. ROBSON. *Bull. Amer. Ceram. Soc.*, **24** [3] 92–93 (1945).—1 figure.

Future development of the archless continuous kiln. C. ROSCHMANN. *Tonind.-Ztg.*, **66,** 231 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [3] 19A (1943).—A suggested design for an archless continuous kiln with an annual production of 20 million building brick is presented. The chambers under fire are roofed over with transportable panels consisting of a layer of insulating brick covered with porous concrete. Each panel is 6 ft. 6 in. long and 18 ft. broad and is pierced with two rows of charging holes. The portable roof is moved as required by traveling cranes which also carry out most of the work of setting and emptying the kiln and loading the brick onto vehicles. The general layout of the plant is illustrated.

Improving low output. ANON. *Brit. Clayworker*, **51** [603] 43 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [9] 107A (1942).—The necessity for an adequately long Hoffmann kiln and a sufficiently high chimney is stressed. The optimum preheating, full-fire, and cooling times must be determined.

Induced draft for annular kilns having inadequate draft. H. HOLZSCHECK. *Tonind.-Ztg.*, **66,** 139 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [1] 4A (1943).—The centrifugal blower is used for induced draft, the fan for suction draft. Three systems are described: (1) direct, in which the waste gases pass through the fan; (2) indirect, in which induced draft is used; and (3) combined system, in which part of the waste gases pass through the blower and

are used to cause induced draft. The waste-gas flues should be insulated and free from sudden changes in direction. Fan corrosion is considered; it is reduced if the waste-gas temperature is kept above the dew point.

Kiln problems in the brick industry. S. NEUWOHNER, W. MENDHEIM, ET AL. *Tonind.-Ztg.*, **65**, 549 (1941); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [8] 95A (1942).—N. considers that a tunnel kiln designed for an annual production of 15 million standard brick will solve the firing problems in the brick industry. The width of the tunnel should be about 10 ft. and the height about 5.5 ft. to obtain a uniform weekly output of 300,000 brick. To obtain better movement of the kiln cars, a double kiln is suggested, consisting of two tunnels side by side, each 6.5 ft. wide and about 5 ft. high. M. states that tunnel kilns of abnormal size are already operating and thinks this of significance in view of the expected postwar demand for building materials.

Lighting up a circular kiln. ANON. *Tonind.-Ztg.*, **66**, 182 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [3] 19A (1943).—Difficulty in starting the fire in a circular kiln was eventually traced to the back wall of the ashpit in the temporary fire mouth, which had been built to the same checkered pattern as the kiln setting. Symptoms were (1) sluggish fire with fire-mouth door and ashpit door open, (2) slight improvement with ashpit door closed, and (3) complete absence of draft with fire-mouth door closed and ashpit door open.

Note on the relation of heat loss and temperature in furnaces. G. O. TAYLOR. *Metallurgia*, **26**, 161 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [11] 131A (1942).—T. gives a useful compilation of equations for calculating heat loss from furnaces. These equations include (1) relation between heat loss from exterior of furnace and the temperature of the exterior, (2) relation between heat loss from exterior of furnace and wastage of fuel, and (3) relation between internal and external furnace temperatures and wall thickness.

Proportional-mixer kiln. J. T. ROBSON. *Bull. Amer. Ceram. Soc.*, **24** [3] 90–92 (1945).—2 references, 1 figure.

Proposals for standardization of kilns, driers, and gas producers in the ceramic industry. P. GATZKE. *Tonind.-Ztg.*, **66**, 227 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [3] 19A (1943).—The Kiln-Construction Subsection of the Wirtschaftgruppe Bauindustrie, Berlin, has drawn up proposed standards for the dimensions of kilns, driers, and gas producers. Five, or in some cases six, standard capacities or outputs are recommended for various types of kiln and drier, and the corresponding internal and external dimensions, grate area, etc., are tabulated.

Round tunnel kiln and the burning of blue brick. ANON. *Tonind.-Ztg.*, **66**, 119 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [1] 3A (1943).—A discussion on the layout described by Szoks (see "Twin . . .," this page).

Stokers for brick kilns. ANON. *Tonind.-Ztg.*, **65**, 574 (1941); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [8] 96A (1942).—Several German patents are reviewed.

Twin works for making blue brick. E. V. Szoks. *Tonind.-Ztg.*, **65**, 305 (1941); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [5] 63A (1942).—Normal preparation machines feed two sets of triple concentric tunnels; the inner are clay driers, the central are brick driers, and the outer are kilns. The speed of each tunnel is regulated to give continuous production. R. STECKEMESSER. *Tonind.-Ztg.*, **65**, 417 (1941).—S. considers the suggested layout impracticable due to the mechanical difficulty in moving a heavy setting around a circular kiln; the high temperature necessary for firing blue brick is also considered to militate against the use of this type of kiln. A. HABLA. *Ibid.*, p. 517.—H. disagrees with Steckemesser's criticisms, pointing out that the circular tunnel kiln has already proved successful. The new plant is not considered suitable for common-brick production owing to its high capital cost but might prove economical for more specialized products. See "Round . . .," this page.

Water-smoking studies. HIELSCHER. *Tonind.-Ztg.*, **66**, 177 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [2] 11A (1943).—With most annular kiln steam eliminators, hot air is introduced into the chamber through the feed holes and below simultaneously. It takes up part of the residual water of the green brick, which is carried off through the flue to the stack. Two opinions as to how the air acts and the direction of flow in the water-smoking chamber are discussed, illustrated, and proved wrong. The theory proved correct is that, soon after its entrance into the water-smoking chamber, the hot air spreads out horizontally below the arch and then falls in isothermal layers, which become progressively colder; finally the lowest layer is drawn off sideways into the flue. It is believed that the layer of air lying at the bottom is removed into the flue by chimney draft, and then the air layers move downward altogether; thus a layer of air is gradually led away from below, and a new hot-air layer appears above. The systematic smoking of a 16-chamber annular kiln for the firing of face brick is described. **Discussion.** F. GELHARD. *Tonind.-Ztg.*, **66**, 185 (1942). H. MEYER. *Ibid.*, p. 233.

PATENTS

Apparatus for cooling materials discharged from kilns. TRAYLOR ENGINEERING & MANUFACTURING CO. Brit. 566,761, Jan. 24, 1945 (July 21, 1942).

Furnaces of intermittent ovens and kilns for firing ceramics. W. G. BARRATT AND J. Y. M. HALSALL. Brit. 566,838, Jan. 31, 1945 (Aug. 3, 1943).

Prefabricated ceramic combustion chamber. FRANK CHRISTENSON. U. S. 2,370,008, Feb. 20, 1945 (Oct. 28, 1943). 3 claims. (Cl. 158-1).—1. A prefabricated ceramic combustion chamber for use in liquid fuel burning installations comprising a generally U-shaped rear section made of refractory material and including a vertical rear wall and parallel vertical side walls.

Geology

Celestite in Buffalo Cove, Fentress County, Tenn. THOMAS L. KESLER. *Econ. Geol.*, **39** [4] 287–306 (1944).—A deposit of celestite previously considered to be barite is discussed. The mineral aggregates consist of celestite, dolomite, calcite, and very small amounts of sphalerite, anhydrite, and pyrite. The maximum content of celestite is 96%. Open quarry methods are necessary because of overlying shale. B.C.R.

Control of minute particles. F. B. SHAY. *Foote-Prints*, **16** [2] 3–8 (1944).—Particle size offers the most rapid and convenient method for empirical control of the physical properties of a particular mineral or chemical. Fine particles involve very large numbers of units (700,000,000 per pound at 200-mesh) which cannot be inspected individually. Wire sieves provide the equivalent of "go" and "no go" gauges. Since these small gauges must be imperfect, a tolerance is allowed, e.g., 8% in average opening and 60% in maximum opening at 200-mesh. Tables of data illustrate the variations with screen, with sampling, and with time and type of shaking. The many pitfalls in screen testing indicate the importance of standardized procedures and rational specifications. A.P.

Dip and strike from three nonparallel drill cores lacking key beds. JAMES GILLULY. *Econ. Geol.*, **39** [5] 359–63 (1944).—In commenting on Bucher's procedure (*ibid.*, **38**, 648–57 (1943)), G. offers a less complicated method for obtaining the same result, the mathematics of which are discussed in detail. B.C.R.

Discussion on postwar possibilities for utilizing British Columbia's industrial minerals. F. A. FORWARD, G. M. HUTT, AND HUGH S. SPENCE. *Can. Mining Met. Bull.*, No. 393, pp. 78–82 (1945). G.M.H.

Dry polishing of opaque materials. H. J. FRASER AND R. VON HEUNE. *Amer. Mineralogist*, **27**, 261 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [9] 112A (1942).—The process of polishing opaque materials is restudied

with the hope of speeding up the process without undue loss of quality. The physical character and structure of laps found satisfactory are presented. Determinations are given of the rate of removal of material during the various stages of grinding and polishing. Various types of mechanical heads are described; the method of charging laps is discussed in detail, and the complete process of mounting and polishing is outlined.

Geology of the Antarctic Continent and its relationship to neighboring land areas. ARTHUR WADE. *Proc. Roy. Soc. Queensland*, **52**, Pt. 1, 24–35 (1941); abstracted in *Bull. Amer. Assn. Petroleum Geol.*, **28** [12] 1756–57 (1944). G.M.H.

Magnesite plant improvements. ANON. *Rock Products*, **48** [1] 230 (1945).—In anticipation of postwar demands, the Northwest Magnesite Co. is opening up its Keystone quarry in the State of Washington. B.C.R.

More recent knowledge of the nature of clay. E. DITTLER. *Tonind.-Ztg.*, **65**, 515, 528 (1941); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [8] 93A (1942).—Clay is distinguished from kaolin by its plasticity, its absorption capability, its hygroscopicity, and its chemical composition. D. discusses the three groups into which clays can be divided: (1) residues of rock-formed minerals; (2) quartz, feldspar, mica (muscovite, biotite, sericite), calcite, secondary hornblende, augite, limonite, pyrites, dolomite, glauconite; and (3) clay minerals and biogenic and organogenic admixtures. The chemical composition is given of the most important clay minerals, and grain-size distribution and chemical and mineralogical analyses are tabulated. New methods of investigation with the electron microscope and a new ultramicroscope have shown that the constituents of clays are not amorphous but possess a crystalline character and that the clay mineral allophane is for the most part halloysite. It is proved that rational analysis is subject to fundamental error. Absorption and base exchange are important properties of clay; the former is largely dependent on the latter. Recent work on the natural and synthetic formation of kaolin and on the identity of prokaolin is reviewed.

Notes on the compressibility of clays. A. W. SKEMPTON. *Quart. Jour. Geol. Soc. London*, **100** [397–98] 119–35 (1944).—In the lower rank metamorphic processes there is a sequence whereby mud is converted to clay and finally to a shale. The process is essentially one involving pressure and the compressibility of the sediment. S. has studied the compressibility of a number of sediments of different types in the laboratory. The compressibility of a clay or mud can be described by means of several constants. Terzaghi (*Proc. Harvard Conf. Soil Mechanics*, **1**, 161) has defined the liquidity index according to the following equation: Liquidity index $= \frac{w/c - PL}{LL - PL}$, where w/c = weight of water ÷ weight of solids × 100, PL = amount of water that must be added to the clay to render it plastic, and LL = liquid limit as determined by the Casagrande apparatus and is defined as the amount of water that must be added to the clay to convert it from a plastic mass to a viscous liquid. For soft clays the liquidity index ranges from 1 to 0.5; for stiff clays it is almost 0; while for shales the index is negative. The laboratory consolidation test provides two other constants for the characterization. In this test, the clay, adjusted to its liquid limit, is placed in an oedometer or compression apparatus. This apparatus consists of a brass ring, in which the clay is confined, and two porous stone ends through which the load is applied. The displacement of the clay is measured with a dial gauge. By applying small increments of pressure over a period of time, a series of pressure vs. ratio data are obtained. The void ratio, ϵ, is the volume of voids per cubic centimeter of solid, and it is related to the water content in the following manner: $w/c = \epsilon/\rho$, where ρ is the specific gravity of the grains. The compressibility of a particular sample can be expressed in the equation $\epsilon = \epsilon_1 - C \log (\rho/\rho_1)$, where C is the slope of the line when the log of the pressure ratio is plotted against void ratio and is called the compression index. The constants ϵ_1 and C are called the constants of compression and are characteristic for a particular clay. A correlation is made between pressure and ϵ_1, C, and the liquid limit for 27 clays. The constants for numerous English muds and clays are listed. 26 references. S.Z.

Progress in the study of exsolution in ore minerals. G. M. SCHWARTZ. *Econ. Geol.*, **37**, 345 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **42** [4] 31A (1943).—A section of this paper deals with the relationship between the oxides of Fe, particularly their mutual solubility. Most natural specimens with hematite along the octahedral planes of magnetite are a result of partial replacement, but possible exsolution has been observed in an iron-ore sinter; this is in agreement with the work of the Geophysical Laboratory.

Searles Lake becomes major lithium source. ANON. *Bull. Amer. Ceram. Soc.*, **24** [3] 115 (1945).

Simple tests for the detection of the beryllium mineral helvite. JOHN W. GRUNER. *Econ. Geol.*, **39** [6] 444 (1944).—A simple, rapid, quantitative method of determining the amount of helvite $[(Mn,Fe,Zn)_4Be_3S_3O_{12}S]$ is presented. The method was developed as a field test in evaluating the deposit at Iron Mt., Sierra County, N. Mex. The material analyzed as follows: SiO_2 32.35, TiO_2 none, Al_2O_3 0.33, Ga_2O_3 trace, BeO 13.75, FeO 16.35, MnO 28.99, ZnO 4.88, CaO 0.23, MgO none, S 5.50, and H_2O 0.17. Method: Place a very small sample of powdered or crushed rock in a 50-ml. beaker and cover with 1 : 5 H_2SO_4. Add a "pinch" of arsenic trioxide (As_2O_3) and boil for 1 to 2 min. Decant the acid and wash with water several times by decantation. While the sample is still covered with water examine it under a binocular microscope. Any helvite present will be stained a brilliant canary yellow due to formation of As_2S_3. The test is sufficiently sensitive to detect one grain of helvite among thousands of the gangue mineral. If the grains are yellow garnet, substitution of metallic Sb for As_2O_3 forms a red stain on the helvite due to the formation of Sb_2S_3. Sphalerite gives the same test in HCl with As_2O_3 but in H_2SO_4 reacts much more slowly and can be distinguished from helvite. Other sulfides do not interfere. B.C.R.

Some clay-water properties of certain clay minerals. R. E. GRIM AND F. L. CUTHBERT. *Jour. Amer. Ceram. Soc.*, **28** [3] 90–95 (1945).—4 references, 6 figures.

Up-grading chrome ore. ANON. *Chem. Trade Jour.*, **111**, 183 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [11] 122A (1942).—A reduction and leaching process intended to remove part of the iron from low-grade chrome ores is mentioned; the Cr:Fe ratio can be increased to 40:1.

Vermiculite—a new western product. J. T. VAN RENSSELAER. *Ind. Gas*, **22** [3] 11–12, 32 (Sept., 1943).—Vermiculite is a hydrous aluminum silicate or a species of mica. When the temperature of the material is raised to approximately 1400°F. in 1 min., complete exfoliation takes place and the particles are puffed to fifteen or more times their original size. Vermiculite is capable of resisting heat up to 2450°F. without fusing. It is cleaned, graded, and sized into four grades. It is used as formed for various insulation purposes and as a loose fill, or it is made up into insulating brick of high load-carrying capacity. The kiln and the tunnel drier for the brick are described. H.K.R.

Zirconium in industry. ANON. *Chem. Eng. Mining Rev.*, **37** [434] 56 (1944).—Zirconium occurs principally in Brazil, Travancore, and New South Wales. Zirconium refractories are inert to silicate slags and other corrosive agents, and as cements they are used for coating other refractories. As an opacifier, zircon is replacing antimony and to some extent tin oxide in vitreous enamels and ceramic glasses. In metallic form it is used as a scavenger in steelmaking. B.C.R.

Chemistry and Physics

Analytical methods for the determination of tungsten. ANON. *Chem. Eng. Mining Rev.*, **36** [429] 249–52 (1944). —Fuse the sample with (1) sodium peroxide in a nickel or iron crucible, not exceeding a dull red heat; (2) potassium bisulfate in a Pyrex or Monex flask; or (3) sodium carbonate in a platinum crucible. Precipitate the tungsten in a hot 10% tannin solution. When cold, add a 10% antipyrine solution (6 ml. per 0.1 gm. WO_3). Wash thoroughly with a solution containing 5 ml. H_2SO_4, 50 gm. $(NH_4)_2SO_4$, and 2 gm. antipyrine per liter. Transfer to a porcelain crucible, burn off carbon at < 150 °C., and weigh as WO_3. B.C.R.

Binary system P_2O_5–$2CaO{\cdot}P_2O_5$: I and II. W. L. HILL, G. T. FAUST, AND D. S. REYNOLDS. *Amer. Jour. Sci.*, **242** [9] 457–77; [10] 542–62 (1944).—Equilibrium relations between phosphoric acid (P_2O_5) and calcium pyrophosphate ($2CaO{\cdot}P_2O_5$) were studied by the method of quenching. Eight crystalline phases are stable at liquidus temperatures: (1) P_2O_5 with a triple point at 580° and 55.5 cm., (2) calcium diphosphate ($CaO{\cdot}2P_2O_5$), m.p. 810°, (3) dicalcium triphosphate ($2CaO{\cdot}3P_2O_5$), m.p. 774° (incongruent), (4) β-calcium metaphosphate ($CaO{\cdot}P_2O_5$), m.p. 977° (metastable), (5) α-calcium metaphosphate, m.p. 984°, (6) trömelite (observed as a series of solid solutions ranging from about 32 to 37% CaO), which is metastable below 915° and melts incongruently at 985°, (7) β-calcium pyrophosphate ($2CaO{\cdot}P_2O_5$), and (8) α-calcium pyrophosphate, m.p. 1353°. The $\alpha \rightleftharpoons \beta$ inversion points of $CaO{\cdot}P_2O_5$ and $2CaO{\cdot}P_2O_5$ lie at 963° and 1140°, respectively. Solid solutions were noted only in the metaphosphate-pyrophosphate system, where they occur on an extensive scale, the range for the β modifications being the greater. B.C.R.

Isomorphism and allotropy in compounds of the type A_2XO_4. M. A. BREDIG. *Jour. Phys. Chem.*, **46**, 747 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [11] 130A (1942). —The occurrence of solid solutions of Ca phosphate in Ca orthosilicate leads to the assumption that the latter may itself belong, above 1420 °C., to the structural group of hexagonal high-temperature forms. See "Phase . . . ," *Ceram. Abs.*, **23** [4] 80 (1944).

Quinaldinic acid as a reagent for the separation of copper and cadmium. A. K. MAJUMDAR. *Analyst*, **68** [809] 242–44 (1943).—In the precipitation of copper with sodium quinaldinate solution in a dilute H_2SO_4 solution, precipitation in a hot solution and the use of hot water for washing are essential in preventing the coprecipitation of cadmium. The precipitate is filtered on a Gooch crucible and dried at 125 °C. Spectral analysis of the copper precipitate showed less than 0.08% cadmium. Cadmium is determined in the filtrate by precipitation with additional sodium quinaldinate solution in a solution neutral to methyl red. The precipitate is allowed to settle in the cold and is then washed with cold water, filtered on a Gooch crucible, and dried at 125 °C. B.C.R.

Rapid determination of alumina in clay and grog. F. CAESAR AND K. KONOPICKY. *Tonind.-Ztg.*, **66**, 47 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [11] 132A (1942).—$Al_2O_3 + TiO_2$ may be estimated in 2 to 2.5 hr. by treating 0.5 gm. of the calcined material with 15 cc. of 1:1 HF, baking the resulting fluorides at 200 °C. to constant weight, and applying a factor which must be determined for each clay. Treatment of pure Al_2O_3, TiO_2, and Fe_2O_3 with HF showed that the fluorides, when baked at 200 °C., are nonhygroscopic and of sufficiently constant composition for weighing. Some replacement of $Al_2F_6{\cdot}H_2O$ by $Al_2F_5OH{\cdot}H_2O$ and of $Fe_2F_6{\cdot}H_2O$ by $FeF_5OH{\cdot}H_2O$ occurs, leading to a possible error in the conversion factor (in the case of Al_2O_3) of ±0.5%. It is assumed that the fluorides of Ca, Al, and the alkalis remain sufficiently constant in amount to permit the application of an empirical conversion factor to the total weight of fluorides. TiO_2 and Fe_2O_3 may be estimated by fusing the fluorides with $KHSO_4$. The limit of error is ±0.8%.

Resemblance between surface films on solids and on water. S. J. GREGG. *Jour. Chem. Soc.* [London], **1942**, p. 696; abstracted in *Trans. Brit. Ceram. Soc.*, **42** [3] 24A (1943).—The quantities *FA* and *FS* can be calculated for the adsorbed film of a gas on a solid from the adsorption isotherm by integration of the Gibbs adsorption equation (F = surface pressure of the adsorbed film, A = area occupied per adsorbed mol., and S = "specific surface" of the adsorbent, i.e., its adsorbing area per gm.). Curves of *FA* against *FS* drawn from published isotherms exhibit close correspondence to surface films on water: the film states gaseous (G), liquid expanded (L_1), liquid condensed (L_2), and the intermediate state (I) between L_1 and L_2 have their counterparts in gas-solid adsorption. From the slope of the *FA*–*FS* curve where it becomes linear, both the adsorbing area, S, and the monolayer capacity of the adsorbent (the number of molecules it can take up per gram in a completed monolayer) can be calculated. Formation of layers more than 1 mol. thick sometimes occurs, but it is not to be associated with the characteristic loops often obtained in the adsorption isotherms of vapors on gels; the *FA*–*FS* curves in the latter cases show that the adsorbed layer remains unimolecular throughout the region covered by the loop and that the hysteresis originates, not in capillary condensation, but in the transformation of state $L_1 \rightleftharpoons I \rightleftharpoons L_2$ occurring within the monolayer.

Separation of copper and cadmium by means of quinaldinic acid. C. F. PRITCHARD AND R. C. CHIRNSIDE. *Analyst*, **68** [809] 244 (1943).—Using the procedure described by Majumdar ("Quinaldinic . . .," this page), the separation was made with satisfactory results; the errors were less than those reported by Lindsey and Shennan (*ibid.*, **65**, 636 (1940)). B.C.R.

Spot-reaction experiments: IX, Catalyzed reactions brought about by photolysis of ferric oxalate. F. FEIGL. *Jour. Chem. Education*, **22** [1] 36–37 (1945).—Under the influence of light, Eder's solution ($HgCl_2 + (NH_4)_2C_2O_4$) reacts according to the equation $2HgCl_2 + (NH_4)_2C_2O_4 \rightarrow Hg_2Cl_2 + 2NH_4Cl + 2CO_2$. The production of CO_2 is proportional to the intensity of the light. In visible light the reaction is due to traces of iron salts. In the same manner ferric oxalate is decomposed to ferrous oxalate and CO_2. In the Eder's solution reaction, and in other cases listed below, the iron ion acts as a catalyst. F. has discussed the following reactions exhibiting this photolysis and applied them as spot tests: (48) reduction of selenious acid by oxalic acid, (49) reduction of iodine by oxalic acid, (50) reduction of $PdCl_4$ by oxalic acid, (51) reduction of tungstic acid by oxalic acid, and (52) reduction of methylene blue by oxalic acid. For Part VIII see *Ceram. Abs.*, **24** [1] 30 (1945). S.Z.

PATENTS

Ceramic preparation. EUGENE WAINER (Titanium Alloy Mfg. Co.). U. S. 2,369,327, Feb. 13, 1945 (May 24, 1941). 4 claims. (Cl. 106–63).

Defluorinating rock phosphate. K. L. ELMORE (Tennessee Valley Authority). U. S. 2,368,649, Feb. 6, 1945 (Oct. 23, 1941). 3 claims. (Cl. 71–47).—3. A process of rendering fluorine-containing rock phosphate available as plant food which comprises (*a*) preparing a fusion charge of rock phosphate and added acidic oxide material in proportions such that for each mol of CaO in excess of that required to form tricalcium orthophosphate in the rock there are present added constituents required for the formation of one mol of hedenbergite ($CaO{\cdot}FeO{\cdot}2SiO_2$) for between 2 to 3 mols of tricalcium orthophosphate ($3CaO{\cdot}P_2O_5$) therein, whereby the charge has a fusion temperature substantially below the fusion temperature of the rock phosphate alone and the melt resulting therefrom has a relatively low viscosity at temperatures immediately above its fusion temperature, (*b*) fusing the charge so prepared, and (*c*) contacting the fused charge with a water-containing atmosphere for a time sufficient to remove a substantial proportion of the fluorine therefrom and render the phosphorus content thereof available as plant food.

Manufacture of zinc oxide. R. L. HALLOWS AND FREDERICK CLEARMAN (Eagle-Picher Lead Co.). U. S. 2,368,922, Feb. 6, 1945 (July 7, 1942). 4 claims. (Cl. 23–148).—1. The process of continuously producing zinc oxide from zinc sulfide by flash fuming with a substantially minimized liberation of iron and copper compounds present in the zinc sulfide, which comprises taking particles of zinc sulfide within a range of 5 to 500 microns in diameter, dispersing the particles into an oxidizing atmosphere, heating to a temperature sufficient to form an outer layer of zinc oxide on the particles, continuing the heating to a temperature sufficient to volatilize the zinc oxide from the particles, and separating the volatilized zinc oxide from the unvolatilized iron and copper compounds in the residual portions of the particles.

Titanium oxide pigment production. J. H. PETERSON (E. I. du Pont de Nemours & Co.). U. S. 2,369,246, Feb. 13, 1945 (Jan. 9, 1942). 20 claims. (Cl. 106–300).—1. A new white titanium oxide pigmentary composition comprising the product obtainable by calcining hydrous titanium oxide and a minor proportion of a mixture of a soluble alkali metal compound and a compound of aluminum.

Vitreous compositions consisting of oxides of alkali metal, phosphorus, and other selected divalent metal. C. S. KING (Blockson Chemical Co.). U. S. 2,370,472, Feb. 27, 1945 (Oct. 7, 1940). 11 claims. (Cl. 252–1).—1. A homogeneous vitreous material as a glassy water-soluble fusion product consisting analytically of the oxides A_2O, P_2O_5, and MO wherein A_2O is alkali metal oxide, MO is oxide of divalent metal M, and M is metal selected from the group consisting of magnesium, calcium, strontium, and barium, the P_2O_5 being present to an extent in the range $33^1/_3$ to 50 molar % of the total molar content of the oxides, the MO being present to an extent in the range 2.5 to 17.5 molar % of the total molar content, and the A_2O being present to an extent ranging upwardly from 32.5 molar % to the total molar content.

General

Bulk materials storage. W. G. HUDSON. *Chem. & Met. Eng.*, **52** [1] 108–11 (1945).—All generally used methods of bulk storage are reviewed, together with some of the newer devices, e.g., the bulldozer, carryall, and freight-car dumper. B.C.R.

Care and repair of compressed-air equipment. ANON. *Glass Ind.*, **25** [6] 260–61, 280; [7] 310–11, 327; [8] 361, 376 (1944).—Proper care and maintenance of air-compressor equipment is essential if automatic production of glassware is to be kept at capacity. This article is based on publications of the Compressed Air Institute and the Manual of Engineering Instructions issued by the U. S. Navy. After a discussion of the maintenance and repair of the compressor proper, lubrication and supplemental equipment, such as air filters, intercoolers, and aftercoolers, are considered. A.P.

Compressed air leakage and waste. ANON. *Glass Ind.*, **25** [2] 67, 82 (1944).—Air leaks are usually ignored by the maintenance crew but may be costly. Repacking valve stems, shutting off branch lines when not in use, properly clamping hose ends, automatic shut-off blow-guns, and water separators are mentioned as means of eliminating air wastage. A.P.

Lithium compounds in air conditioning. K. S. BERGSTRESSER. *Foote-Prints*, **16** [2] 9–16 (1944).—Lithium is used in air conditioning because of the hygroscopic nature of certain lithium salts. For widespread use in home units, certain difficulties will have to be overcome, such as sludge formation in the brine and corrosion of the metal equipment. A.P.

Recent developments in wage and salary stabilization. O. C. COOL. *Glass Ind.*, **25** [9] 402–403 (1944).—Four basic changes have been made in the wage and salary stabilization regulations. A.P.

Reducing absenteeism and turnover. ANON. *Glass Ind.*, **25** [2] 66, 84 (1944).—Attendance can be preserved not through disciplinary methods but by exploring and removing the causes of absenteeism and turnover. A.P.

Silicosis: a review. E. J. KING. *Fuel*, **21**, 74 (1942); abstracted in *Trans. Brit. Ceram. Soc.*, **41** [9] 112A (1942).—The incidence and study of silicosis is briefly traced from its recognition by Dimerbrock in 1649. The early theory of the mechanical effect of SiO_2 dust on the lungs is shown to be invalid, the disease being due rather to the actual toxicity of silicic acid. Solubility data are given for different forms of SiO_2 and for some silicate minerals; the depression of the silica solubility by Al is discussed. Recent work has suggested that although Al has been shown to inhibit silicosis development in rabbits, human lung tissue may not react in a similar manner.

Southern Research Institute. ANON. *Monthly Rev.* (Federal Reserve Bank of Atlanta), pp. 77–78 (Sept., 1944); reprinted in *Bull. Amer. Ceram. Soc.*, **24** [3] 116–18 (1945).

What glass manufacturers should know about veteran rehiring. O. C. COOL. *Glass Ind.*, **25** [7] 313–14 (1944). A.P.

William A. Harty, President and General Manager, Exolon Co. ANON. *Bull. Amer. Ceram. Soc.*, **24** [3] 87–90 (1945).—4 photos.

SEPARATE PUBLICATIONS

Some Hazards of Auxiliary Fans in Coal Mines. D. HARRINGTON AND R. G. WARNECKE. *U. S. Bur. Mines Information Circ.*, No. 7298, 27 pp. (1944). Free.—The use of portable blower fans in coal mines is increasing, despite the fact that such equipment has been the direct or indirect cause of many explosions, according to a survey among 900 coal mines examined by Federal coal-mine inspectors. This report cites the numerous hazards created by blower fans, viz., recirculation of the air, which may permit harmful accumulations of noxious or explosive gas; the movement, en masse, of bodies of gas from rooms to entries where ignition sources may be encountered; the use of nonpermissible motors on the fans, which may ignite gas; and the possibility of a fire originating at the fan installation. R.A.H.

Studies of the Effect of Humidity on the Sensitivity and Dispersion of Black Powder. RAYMOND MOORE WITH WILBERT J. HUFF. *U. S. Bur. Mines Rept. Investigations*, No. 3782, 18 pp. (1944). Free.—The authors deal with the safe handling and use of black powder such as is widely used in the mining industries. Besides giving detailed facts about the effect of moisture on the powder, they show that fine-grained powders are ignited more readily than coarse-grained ones; that black powder is relatively insensitive to friction; and that black powder should be kept cool. R.A.H.

Transition Opportunities. ANON. Published by *New York Journal of Commerce*, 63 Park Row, New York 15, N. Y., 1945. Price 25¢. Reviewed in *Bull. Amer. Ceram. Soc.*, **24** [2] 55 (1945).

PATENT

Mold sand core. W. C. DEARING AND L. S. MEYER (Plaskon Co., Inc.). Can. 424,252, Dec. 5, 1944 (July 8, 1943; in U. S. Nov. 5, 1942). G.M.H.

THE BULLETIN SECTION

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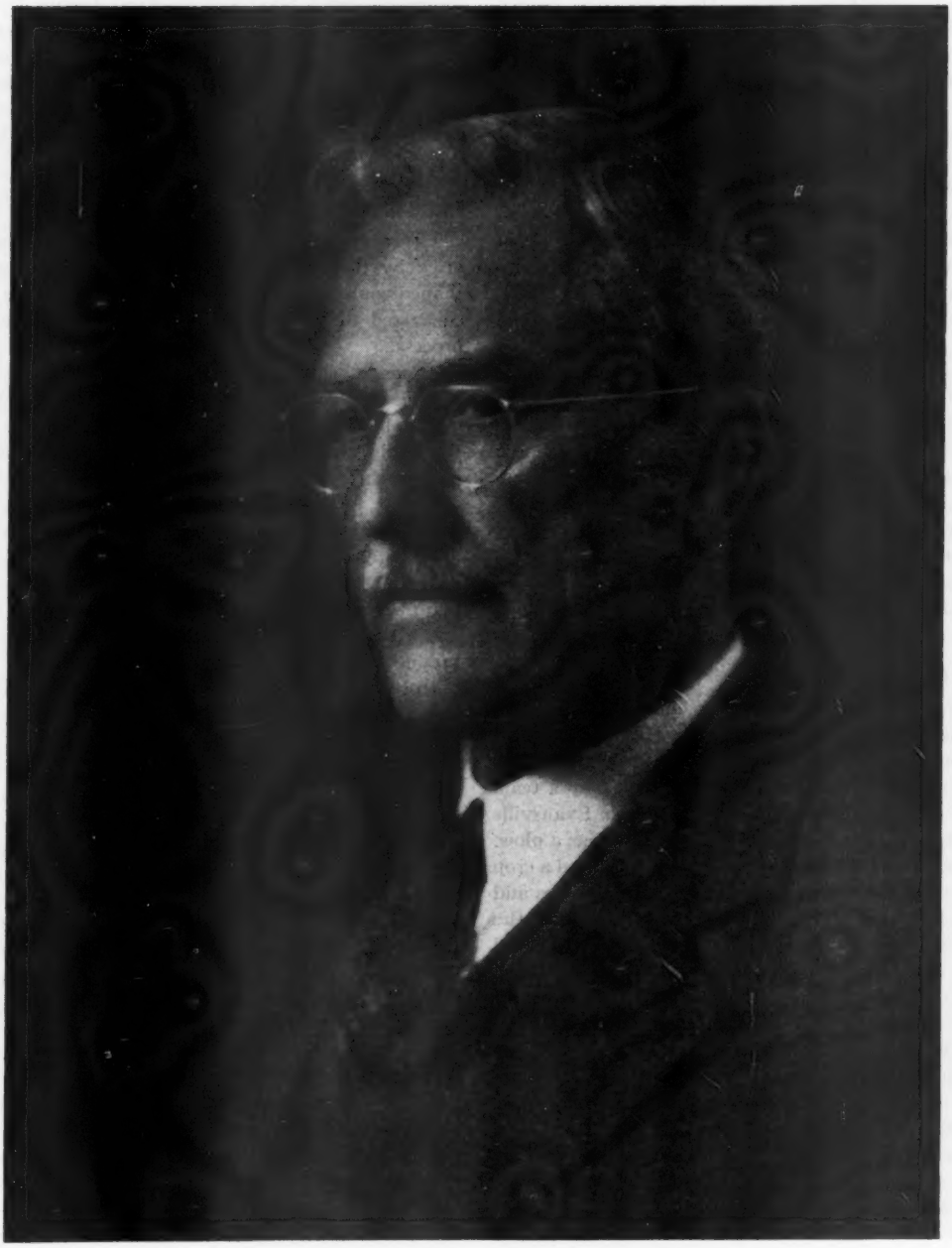

HENRY CHARLES KLEYMEYER

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Father Purchased Plant in Henderson, Kentucky

In 1865, Henry Kleymeyer of Evansville, Indiana, at the age of twenty-four, became a brick manufacturer when he took over a small plant at Henderson, Kentucky, which was for sale because the previous superintendent, a rabid abolitionist, had been ridden out of this small Kentucky community on a rail. The Kleymeyer family has been in the brick and tile business ever since.

The Henderson plant operated as H. Kleymeyer & Company for a number of years and then became the Kleymeyer-Klutey Brick & Tile Works. In 1886, the elder Kleymeyer formed the Louisville Drain Tile Company at Louisville, Kentucky, which grew into the present Southern Brick & Tile Company of that city.

In 1872, a son, Henry Charles Kleymeyer, was born, who was destined to expand the interests of the family in the clay products field still further. As a boy, he spent much of his time while not in school around the brick plant and saw its development from handmade brick fired with wood in a scove kiln to present-day production methods with automatic machinery and controlled firing in patented permanent kilns.

After schooling in public and private schools of Henderson and a course in an Evansville business college, young Henry worked at various jobs in the plant at Henderson, served a year as engineer at the plant in Louisville, went back to Henderson to install the first set of double-entry books of accounting which the company used, and in April, 1895, when not quite twenty-three years old, crossed the Ohio River to Evansville, Indiana, to start his management career, just a half century ago.

Just a Half Century Ago

The story of that first season is an interesting one. Young Kleymeyer, accompanied by Herman Bredenkamp, a foreman at the Henderson plant, drove the winding river road to Evansville in a wagon pulled by a team of mules. The first purchase they made in Evansville to commence the construction of a brick plant was a plow. They plowed up a portion of the ground and planted a crop of corn so that they would have feed for their horses and mules the following year and then started to build the plant. With very little hired help, they mixed mud and laid brick to build a few of the old-type updraft kilns, then with hammer and saw built some open racks to serve as a drier. Eventually the First Avenue Brick & Tile Company was ready to operate in competition with the fifteen handmade-brick yards and four steam plants already in existence in Evansville. In November, 1895, he went back to Henderson to marry his fiancée, Miss Nellie Schmitt, and returned with his bride to Evansville to live on a salary of $50 a month. The business prospered and slowly grew.

By 1902, the family of Henry C. Kleymeyer included three sons and one daughter, and he decided that further expansion was necessary in his business activities to keep pace with his increased financial requirements. In January, 1903, he organized the Standard Brick Manufacturing Company with the Suhrheinrich brothers, who operated a brick plant at Washington and Kentucky Avenues, and the new company bought the Helfrich plant located on the Upper Mt. Vernon Road at the west edge of the city. At the time of purchase, the Helfrich plant was manufacturing brick by the sand-mold process, as was the Suhrheinrich plant and the First Avenue Brick & Tile Company, which remained a separate corporation. The sand-mold brick had been manufactured from surface clay, but when the dry-press method was adopted, the underlying shale was ground to powder form and a much stronger brick was produced which was greatly in demand throughout the Middle West.

First Continuous Kiln Installed

The west-side plant was soon rebuilt to manufacture brick by the dry-press method, and in 1907 a large U-shaped continuous kiln was built. In 1914, the plant was converted to the manufacture of brick by the stiff-mud process.

As more brick was shipped to outside points, the lack of railroad facilities was quite a handicap. Mr. Kleymeyer had some difficulty in convincing the L. & N. Railroad Company that a switch was feasible, as it would require three-quarters of a mile of track to the L. & N. main line, but his confidence was justified, as the plant was soon shipping one thousand cars of brick a year over the new switch, the longest private switch in the city.

Production was gradually increased at the west-side plant with the introduction of rough-textured face brick, and round downdraft beehive-type kilns were built to produce a wide variety of shades and textures.

In 1916, the plant at Washington and Kentucky Avenues was abandoned and the site was sold for real-estate development. In the same year, the company purchased a small plant southeast of the city on the Illinois Central Railroad and improved and developed it. This plant was almost totally destroyed by fire in 1927, most of the buildings on the plant when it was purchased having been of frame construction. The plant was rebuilt of fireproof construction. This same plant was covered with eight feet of water in the great flood of 1937, but after it was dug out of the mud it resumed the manufacture of drain tile, building tile, and red face brick. The name of the company was changed about fifteen years ago to the Standard Brick and Tile Corporation.

Pioneer in Production Methods

Henry C. Kleymeyer was one of the pioneers in developing new production equipment and methods and often devised improvements which soon found general use. He welcomed visits by other manufacturers to his plant and often said that they were welcome to anything they found which they could "carry away under their hats." When, however, he developed a new continuous system of firing periodic kilns, he applied for and was granted a patent so that he could protect his own rights to use the system in the event someone else tried to copy and patent

it. It is a source of great pride to him that in 1944 he received a substantial royalty payment for the use of the Kleymeyer system by a manufacturer in South Africa.

Another of the Kleymeyer group of plants is the West Point Brick Company at West Point, Kentucky, about twenty miles southwest of Louisville, Kentucky, and on the edge of the Fort Knox Reservation. Control of this plant was secured in 1912 when it was a small rundown sand-mold brick plant. It was subsequently developed into a modern stiff-mud brick plant manufacturing high-grade smooth red and rough-textured face brick for the Louisville market. Most of the permanent buildings built at Fort Knox by the Government were constructed with brick from the West Point plant, which furnished many millions of brick for this purpose.

Served as Officer in Many Associations

Mr. Kleymeyer and his father always believed in associations organized for the development and improvement of the industry and not only affiliated with them but gave them their active support. Over a period of years, Henry C. Kleymeyer served many of these organizations as an officer or director. In addition to having been president of the National Brick Manufacturers Association, he has served as vice-president of the Common Brick Manufacturers of America, vice-president of The American Ceramic Society, and a director of the American Face Brick Association.

In 1936, The American Ceramic Society honored him with the title of "Fellow of The Society" for his contributions to the industry.

His interests during his most active period were not confined, however, to the clay products industry. He was recognized for his civic leadership and served the community in many capacities. Not only is he a past-president of both the Evansville Chamber of Commerce and the Manufacturers Association, but he served as a director on the boards of the Indiana State organizations of both the Chamber of Commerce and the Manufacturers Association. His interest in inland waterway development led him to serve as a vice-president of the Ohio River Improvement Association and the Mississippi Valley Association. He was one of the leaders whose energetic advocacy of a river-rail terminal at Evansville led to the eventual establishment of the ultramodern Mead Johnson Terminal.

Bridge Over the Ohio River

He also fought long and hard for the construction of a free bridge over the Ohio River at Evansville for automobile and truck transportation and was instrumental in devising the fifty-fifty plan whereby the bridge was finally constructed by the states of Indiana and Kentucky. When the bridge became toll free in 1941, it became the only toll-free bridge crossing the Ohio River between Pittsburgh and the mouth of the Ohio at Cairo, Illinois.

Mr. Kleymeyer has been an active member of the Bethel Evangelical and Reformed Church for many years and has served on the church council.

He has been for many years a trustee of Evansville College, serving as treasurer of the board. He has assumed similar capacities for the Evansville Y.M.C.A., where he is also treasurer of the board of directors.

Other business activities include directorships of the Old National Bank in Evansville, the Southern Indiana Gas and Electric Company, the Sunbeam Electric & Manufacturing Company (manufacturers of the Coldspot electric refrigerator), and the vice-presidency of the Imperial Desk Company.

In recent years, Mr. Kleymeyer has relinquished active supervision of the Standard Brick and Tile Corporation and has assumed the position of chairman of the board. One of his sons, Ralph, is president of the Company and another son, Clifford, is secretary-treasurer. He still retains the presidency of the Southern Brick & Tile Company and the West Point Brick Company.

Devotes Time to Improvement of Agriculture

This, however, by no means has meant retirement. He has simply transferred some of his energy and attention to agriculture, which has long held his interest. On more than five hundred acres of farmland at the edge of Louisville, Kentucky, he has developed some of his theories of farming. A firm believer in subsoil cultivation, Mr. Kleymeyer puts his theories into operation with the most modern of farm machinery. He does not use horses or mules or the moldboard plow on any of his land. Blueprint layouts of the farms show the record of each field and indicate the yearly schedule for rotation of crops, fertilization, and subsoiling. Several hundred hogs are raised each year, and the farm has a modern hog "maternity home" to insure proper handling of the semiannual litters. Usually about one hundred steers and heifers are purchased for feeding, so that practically all of the crops raised leave the farm on the hoof.

Henry C. Kleymeyer is the type of man who will always be actively engaged in improving something, and he is looking forward to the next fifty years with the same zest that has made such a full life out of the past fifty years of active participation in the affairs of his community and business.

(1945)

SIGHTING PANEL INCREASES EFFICIENCY OF NAVY CORSAIRS

American Navy pilots have a decided advantage over enemy planes in night fighting, in clouds, and at other times of low visibility. This advantage is secured by the installation on Navy Corsair fighters of a bullet-resistant glass panel of such high-precision quality that it is used directly as a gun-sight reflector.

The "night-fighter panel" is made of laminated plate glass, is $1^1/_2$ inches thick, and weighs approximately 50 pounds. Development of the panel made it possible to eliminate a reflector plate usually used for sighting.

The panel is made with glass from the special plate-glass production of the Libbey-Owens-Ford Glass Co., Toledo, Ohio. A specially developed method is used to select glass which is free from optical defects that might interfere with proper functional use of the gun sight. Precision grinding and polishing, plus resurfacing of the glass after lamination, produce the required optical qualities.

BALL CLAY INVESTIGATION

Symposium III, 46th Annual Meeting, April, 1944

By Ralston Russell, Jr., *Chairman*

Revised Discussion Outline

I. Introduction

By R. Russell, Jr., Research Laboratories, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

(1) History of Project
(2) Consideration of Kaolins
(3) Statement of Objectives
(4) Decision Regarding Classification
(5) Committees and Appointments

II. Discussion of Objectives

By A. L. Johnson, Division of Ceramics, Massachusetts Institute of Technology, Cambridge 39, Mass.; F. P. Hall, Onondaga Pottery Co., Syracuse, N. Y.; and Hewitt Wilson, Electrotechnical Laboratory, U. S. Bureau of Mines, Norris, Tenn. (presented by Sidney Speil).

III. Fellowship Proposal

By R. Russell, Jr.

IV. Project Organization

By G. A. Bole: Engineering Experiment Station, Ohio State University, Columbus 10, Ohio.

V. Variations in Plastic Character

By A. S. Watts: Department of Ceramic Engineering, Ohio State University, Columbus 10, Ohio.

VI. Ball Clay Test Methods in Current Use

By C. M. Lambe, Jr., U. S. Gypsum Co., Pittsburgh, Pa.; G. W. Phelps, United Clay Mines Corp., Trenton 6, N. J.; R. C. Meeker, Kentucky-Tennessee Clay Co., Alliance, Ohio; J. R. Beam, Universal Sanitary Mfg. Co., New Castle, Pa.; Hewitt Wilson, Electrotechnical Laboratory, U. S. Bureau of Mines, Norris, Tenn. (presented by Sidney Speil); A. S. Watts, Department of Ceramic Engineering, Ohio State University, Columbus 10, Ohio; and E. J. Weiss, Ohio State University, Columbus 10, Ohio.

VII. Tentative Standards

By J. R. Beam, Universal Sanitary Mfg. Co., New Castle, Pa.; L. E. Thiess, General Electric Co., Schenectady 2, N. Y.; R. E. Gould, Buffalo Pottery, Inc., Buffalo 10, N. Y.; A. J. Hedquist, Taylor, Smith & Taylor Co., Chester, W. Va.; Harry Thiemecke, Homer Laughlin China Co., Newell, W. Va.; Edward Schramm, Onondaga Pottery Co., Syracuse 4, N. Y.; J. W. Whittemore, Virginia Polytechnic Institute, Blacksburg, Va.; Sidney Speil, Electrotechnical Laboratory, U. S. Bureau of Mines, Norris, Tenn.; V. J. Roehm, Kentucky Clay Mining Co., Alliance, Ohio; A. S. Watts, Department of Ceramic Engineering, Ohio State University, Columbus 10, Ohio; and K. C. McCartt, Universal Sanitary Mfg. Co., New Castle, Pa.

Report of Symposium III

I. Introduction

This is a report of the third consecutive annual symposium dealing with the subject of ball clays. Symposium I dealt with the use of ball clays in various types of whiteware bodies and with general test methods. Symposium II was devoted to specific methods of material selection and distribution, sample preparation, and test procedures. Records of these two symposia have been published previously in *The Bulletin*.[1] The entire project is under the direction of the Research Committee of the White Wares Division and is sponsored jointly by the Materials and Equipment and White Wares Divisions.

The original title of this project was "The Testing and Classification of Ball Clays." The Advisory Committee recently approved a change in title to "Ball Clay Investigation," and it is as such that this project will hereafter be known.

Several proposals have been made that the currect project include kaolins as well as ball clays. This is considered desirable because of the similar problems and related interests involved with these two general types of whiteware clays. As a result of these proposals, the Chairman circulated a questionnaire among kaolin producers and suppliers. The results were overwhelmingly in favor of including kaolins and indicated a cooperative attitude on the part of kaolin producers and suppliers. The Committee has no intention of confusing the present study by the immediate consideration of kaolins, but it is planned eventually to expand the scope to obtain general information on the properties and test methods for kaolins as well as for ball clays. This is a quite natural evolution in view of the related nature of these materials.

A redefinition of the objectives would no doubt be useful before proceeding with the discussions. The objectives as previously listed are:

(1) *The development of standardized methods of testing and control and the universal adoption of these methods for ball clay testing.*

(2) *A study and correlation of the fundamental vs. the general physical properties of ball clays to permit better understanding in their testing, selection, and use.* This is simply an attempt to interpret the relationship which exists between the more abstract fundamental properties (grain size, surface characteristics, organic content, etc.) and the more commonly determined physical properties (water of plasticity, shrinkage, strength, etc.).

(3) *Increased knowledge and insight into the reasons for the characteristic nature of clays.* This objective implies a better understanding of how and why different clays have acquired their composite, individualistic characteristics.

It is noteworthy to record a decision made by the Advisory Committee with respect to the possible classification of commercial ball clays. It was unanimously agreed that at no time during the course of this investigation will any attempt be made to classify identifiable commercial clays and that no data on identifiable clays will be provided which might influence the selection and use of competitive materials. The investigation will thus be confined to a study of test methods, the development of standard procedures, a study of properties of representative unidentified clays, and a consideration of the nature of clays. No clays

[1] *Bull. Amer. Ceram. Soc.*, **21** [11] 248–91 (1942) and **23** [2] 47–53 (1944).

used in this investigation will carry any commercial identification. It was generally agreed that the only classification which might come from this investigation is a definition of the properties which a clay must have to be classified as a ball clay, kaolin, etc. Such a definition could hardly affect a choice between similar materials for a given application.

The Ball Clay Advisory Committee has been enlarged to provide adequate personnel for the direction of various phases of the project. The current Committee is as follows: J. R. BEAM, Universal Sanitary Mfg. Co., New Castle, Pa.; R. M. CAMPBELL, New York State College of Ceramics, Alfred, N. Y.; R. F. GELLER, National Bureau of Standards, Washington, D. C.; R. E. GOULD, Buffalo Pottery, Inc., Buffalo 10, N. Y.; C. W. HALL, United Clay Mines Corp., Trenton 6, N. J.; F. P. HALL, Onondaga Pottery Co., Syracuse, N. Y.; C. G. HARMAN, Department of Ceramic Engineering, University of Illinois, Urbana, Ill.; A. J. HEDQUIST, Taylor, Smith & Taylor Co., Chester, W. Va.; A. L. JOHNSON, Division of Ceramics, Massachusetts Institute of Technology, Cambridge 39, Mass.; T. A. KLINEFELTER, Southern Experiment Station, U. S. Bureau of Mines, Tuscaloosa, Ala.; R. C. MEEKER, Kentucky-Tennessee Clay Co., Alliance, Ohio; L. F. POWELL, Old Hickory Clay & Talc Co., Paducah, Ky.; V. J. ROEHM, Kentucky Clay Mining Co., Alliance, Ohio; EDWARD SCHRAMM, Onondaga Pottery Co., Syracuse, N. Y.; SIDNEY SPEIL, Electrotechnical Laboratory, U. S. Bureau of Mines, Norris, Tenn.; I. E. SPROAT, R. T. Vanderbilt Co., New York 17, N. Y.; HARRY THIEMECKE, Homer Laughlin China Co., Newell, W. Va.; L. E. THIESS, General Electric Co., Schenectady 2, N. Y.; A. S. WATTS, Department of Ceramic Engineering, Ohio State University, Columbus 10, Ohio; J. W. WHITTEMORE, Virginia Polytechnic Institute, Blacksburg, Va.; HEWITT WILSON, Electrotechnical Laboratory, U. S. Bureau of Mines, Norris, Tenn.; and RALSTON RUSSELL, JR., *Chairman*, Research Laboratories, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

It is interesting to note the representative nature of this Committee, as indicated by a grouping of its personnel as follows: five academic representatives, four Government service representatives, five clay producer representatives, five whiteware manufacturer representatives, and three manufacturing research representatives.

An Executive Committee has been elected by the Advisory Committee to steer the various activities and supplement the larger Advisory Committee. The Executive Committee is currently constituted as follows: A. S. WATTS, *Academic Member;* T. A. KLINEFELTER, *Government Service Member;* R. C. MEEKER, *Clay Producer Member;* EDWARD SCHRAMM, *Whiteware Manufacturer Member;* and RALSTON RUSSELL, JR., *Manufacturing Research Member.*

The following Committee appointments were made by the Chairman:

Committee 1, Review of the Literature: HEWITT WILSON.
Committee 2, Producers' Committee: C. W. HALL, R. C. MEEKER, L. F. POWELL, V. J. ROEHM, and I. E. SPROAT.
Committee 3, Cooperations:
Committee 3A, Fellowships: F. P. HALL.
Committee 3B, Bureau of Mines Cooperation: T. A. KLINEFELTER.
Committee 3C, Bureau of Standards Cooperation: R. F. GELLER.
Committee 4, Raw Material Selection and Preliminary Treatment:
Committee 4A, Clays: J. R. BEAM.
Committee 4B, Flint: A. J. HEDQUIST.
Committee 4C, Feldspar and Miscellaneous Raw Materials: HARRY THIEMECKE.
Committee 5, Standardized Methods of Testing and Control (Use of Formed Specimens):
Committee 5A, Standard Compositions: L. E. THIESS.
Committee 5B, Batch Mixing and Preparation: A. S. WATTS and R. E. GOULD.
Committee 5C, Forming of Test Specimens: J. W. WHITTEMORE.
Committee 5D, Drying Treatment: R. M. CAMPBELL.
Committee 5E, Unfired Properties: C. W. HALL.
Committee 5F, Firing, Fired Characteristics and Fired Properties: C. G. HARMAN.
Committee 6, Development of Tests for Properties of Raw Clay:
Committee 6A, Physical Tests: EDWARD SCHRAMM.
Committee 6B, Chemical Tests: SIDNEY SPEIL.
Committee 7, Fundamental Investigation: A. L. JOHNSON; F. P. HALL; E. A. HAUSER, Massachusetts Institute of Technology, Cambridge 39, Mass.; W. KEITH MCAFEE, Universal Sanitary Mfg. Co., New Castle, Pa.; and F. H. NORTON, Division of Ceramics, Massachusetts Institute of Technology, Cambridge 39, Mass.

It was emphasized that all appointments are subject to change and that every committee chairman as listed will have the opportunity to select a working committee of several interested members. It is hoped thus to enlist the assistance of many persons from the White Wares and Materials and Equipment Divisions to make this truly a cooperative effort.

II. Discussion of Objectives

Dr. Russell called to attention the fact that two basic methods have been proposed for carrying out the study of ball clays. One group favors a so-called fundamental method of attack in which the primary aim is to evolve a better understanding of the clays through a study of the more abstract fundamental properties, such as particle size and shape, surface characteristics, adsorbed ions, etc. The second group favors an initial effort along more conventional lines in which a clay is formed into test specimens before the determination of properties such as shrinkage, pore volume, strength, etc. This involves the selection of standardized methods of testing for the properties usually determined in the selection and control of clays in commercial usage. Both groups would include tests along the lines favored by the other group, but there is, nevertheless, a definite difference of opinion as to the preferred chronology of study. The logical solution would appear to be concomitant studies by the two groups to develop all information which may be useful in the final analysis.

A. L. Johnson presented the following remarks relative to the proposed objectives and method of developing the project:

Johnson Discussion

The assumption that the objectives of the Ball Clay Advisory Committee are to be tackled chronologically is valid, else why all the discussion on actual methods to be used in making these tests? The discussion thus far indicates that setting up standard tests is by no means a simple matter, although it is planned to be accomplished first.

Why set up standard tests? Principally so that work on the same material can be compared even though it is carried out in several laboratories. In other words, standard tests allow us to talk the same language when we speak of dry strength, shrinkage, etc. How are such tests set up? Simply by bringing together the best minds on the subject to devise the tests based on experience, knowledge, and vision. It is common knowledge that extreme precautions are required in the testing of the same ball clay, even at an individual plant or mine. Hence numerous factors are submitted for consideration before the setting up of standard testing and control methods. Why all the discussion on as simple a matter as that of standard tests? Do we want standard tests or do we desire an explanation of why one clay has a higher strength than another or why one clay can be used in a casting slip and another cannot? Do we believe that if we measure all ball clays by the same procedure we can then find out why clays differ? This has occurred periodically throughout the history of The Society.

What we need first is not standard test development but a first approach as indicated in objective No. 3, namely, "increased knowledge and insight into the reasons for the

characteristic nature of clays." When this knowledge has reached a certain level, we can attack objective No. 2 dealing with "a study and correlation of the fundamental vs. the general physical properties of ball clays to permit better understanding in their testing, selection, and use." Notice that the second objective states that before we can test, select, or use clays properly we must have a better understanding of the fundamental nature of clay. Then and only then can we deal with ball clays or any clays intelligently and wisely. Such a procedure will not be dogmatic but will enable us to deal with the problem of standard tests properly. At that time, objective No. 1 will be relatively simple and understandable to the producer and user of clays.

The Committee should be instructed to investigate the manner in which this program, starting with the third objective, should be carried out. The approach should be based on the best reasoning available. Five years ago, such a program was started in the Ceramic Laboratory at the Massachusetts Institute of Technology. The support it has received from industry, including producer and user, speaks for itself. The records of this project have been published in *The Journal.*[2] In the words of the Committee Chairman, "this is not a Committee project, but a group project toward which every person interested in the production, marketing, testing, or use of ball clay should contribute and become a sponsor because of the individual responsibilities growing out of a common interest in ball clays."

To set up standard tests we must have vision. If we are able to set up standard testing procedures and universally adopt the tests, we must also universally accept the results of these tests. Such results may tend to classify clays into groups: strong clays, weak clays; low-shrinking clays, high-shrinking clays; casting clays, noncasting clays, etc. Whether or not such a classification is a function of the Ball Clay Advisory Committee is debatable. The logical approach would seem to be, not through a development of standard tests, but through a fundamental approach devised to determine why and how clays actually behave and to increase our knowledge of the true nature of clays.

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F. P. Hall also discussed the proposed objectives from a somewhat different viewpoint:

Hall Discussion

Two viewpoints must be considered in this proposed study of ball clays. The first or conventional viewpoint favors the standardization and universal adoption of the tests normally employed in testing and control, whereas the second viewpoint favors a development and use of new indices based more on the so-called fundamental properties. The fundamental attack certainly offers promise, for new indices undoubtedly are needed for any complete understanding or evaluation of clays. This method of study, however, should not completely displace the conventional method because too few people who are interested in clays have had any experience with fundamental indices which have yet to stand the test of time. Studies should proceed along both lines and neither should be sacrificed. Any successful conclusion will involve a correlation of the standard conventional methods with the fundamental indices.

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Sidney Speil then presented a discussion of the objectives as prepared by *Hewitt Wilson:*

Wilson Discussion

Our present state of the knowledge of ball clays indicates that their use is an art and not a science. Both fundamental knowledge of their constitution and state of matter and their relation to certain essential and characteristic properties are therefore necessary before the whole story is unfolded and their use becomes a science and before the best use can be made of them.

Ball clays have and are being mined, sold, and used in whiteware bodies and glazes, but because of the lack of accurate knowledge, their maximum efficiency is not being developed in many cases. The quality of the resulting products indicates, however, that the margin of error has sufficed for all practical purposes. Nevertheless, both ceramic manufacturers and clay producers desire to increase this efficiency.

It is believed that (1) the tests now in use by producer and manufacturer for the exchange of data on ball clays are not precise enough for common understanding and are below the standards of tests on other ceramic, metallurgical, and chemical engineering materials, (2) with customary American independence, the tests now in use show variation of purpose, method of operation, accuracy, description, and mathematical expression of the results, (3) these tests can be made more precise with the practical and technical knowledge now at hand, (4) the use of an approved and improved series of simple test specifications would be of value to the whiteware industry, and (5) such a series of tests is necessary not only for the present needs but for checking future synthesis, purification, mixing, and blending of ball clays.

For the present, this symposium is restricted to the plastic and dry properties of ball clays. Nevertheless, the many impurities as well as their physical condition give clays characteristic vitrification behaviors. This development work will direct us to a comprehensive and detailed definition of a ball clay.

The following is suggested as a general initiative pro gram:

Part I

(1) A study of the past reports, methods, and personal experiences as a foundation for this undertaking.

(2) The selection, development, or invention of equipment and methods that will produce precise test data on ball clays.

(3) The selection, followed by the organized study, of the least number of tests that will group and if possible separate individual ball clays by specific properties.

The proposed tests with standard flint additions and controlled water content are dry strength vs. dry pore space and possibly volume shrinkage.

A comparison of dry strength with an accurately determined pore space, under controlled water and nonplastic additions, should give data showing differences between ball clays.

Dry strength probably parallels plastic strength, and pore space is a function of the shrinkage and water content. The dry properties can be more accurately and easily determined than the plastic properties. Even if the data do not describe the clay completely, control by these simple tests will be a step forward.

(4) The most important objective is the correlation of these tests with the manufacturing service and behavior of ball clays.

Part II

The good work on the fundamental properties should be continued, including the excellent studies at M.I.T. and Penn State. No one is more interested than the writer in fundamental causes and the advancement of ceramic science. In this case, where the industry is on a firm basis and operations are not blocked by the lack of fundamental knowledge, it is not necessary to confine all our initial efforts to a study of fundamentals. Ball clays are composed for the most part of kaolinitic minerals, and their magnified plasticity is due mainly to the increased fineness of particles, modified by the organic soluble and mineral impurities. No new principle is needed to understand the special properties of ball clays as compared with other clays.

It is doubtful if a highly mathematical analysis of this semicolloidal system will greatly modify our development of test methods for practical correlation. This does not

[2] *Jour. Amer. Ceram. Soc.*, **24** [2] 64–69 and [6] 189–203 (1941); **25** [12] 336–44 and 344–46 (1942); **27** [3] 77–80 and [5] 149–64 (1944).

mean that theoretical studies should not be continued under the financial support of this group, if they can be run concurrently with the practical tests, but it has been the experience of many standard tests in other organizations that development on a practical basis has preceded the theoretical and has proved of definite and immediate service to the industry.

PART III

The development and improvement of plastic, bonding clays for whiteware.

Synthesis

(1) Mixing ball clays. (2) Mixing ball clays and bentonite. (3) Mixing kaolin and montmorillonite. (4) This may lead to the mass production of the total clay content of standard bodies by the premixing of ball clays, kaolins, and other allied clay types. Entire bodies have been sold in the prepared form on a small scale.

Analysis

The separation of those elements of ball clays which reduce plasticity and cause discoloration. The washing of ball clays on a commercial scale has not been economically encouraging. It has been the history of other mining enterprises that more and more refined purification methods became necessary as the supply of the best ore became critical. Such undoubtedly will be the history of the domestic ball clays and kaolins. It behooves the industry, possibly with Government support, to plan for the more distant future.

Sand can be removed by sedimentation and many of the iron salts by acid treatment, but titania removal is still an unsolved problem. Future necessity may be the only prod that will cause the consumer to pay the increased cost of purification.

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Dr. Russell stated that there is no doubt that the fundamental methods are of general interest to all producers and users of ball clays, but that most of them are currently more familiar with and use conventional test methods, and consequently might lose interest if all attention were devoted to methods which are hardly advanced to the stage of practical usefulness. One primary reason for carrying on this project is to promote interest and cooperation among all producers and users, and this can only result if the practical aspect, as viewed in the light of current usage, is not discarded. The objective, therefore, of developing standardized methods of testing and control along conventional lines must continually receive attention by one group. It is highly desirable, however, that a second group study the clays from a more fundamental viewpoint.

There is a general agreement that some practical tests are needed which will permit any producer or user to obtain accurate and comparable data, and the desired standardization of tests as proposed should accomplish this result. These tests would usually require mixing of the plastic clay with some nonplastic, such as flint, and forming specimens which would be tested according to specified procedures. The fundamental tests would mostly be made on the raw clay unmixed with other materials and would include tests such as grain size, soluble salts, organic constituents, surface character, and others which it has already been planned to include.

Dr. Johnson was not opposed to the concomitant study of ball clays by the two basic methods, and a motion was unanimously approved that both standardized tests and fundamental research should receive attention.

III. Fellowship Proposal

Dr. Russell presented a report on the possible establishment of fellowships as a means of expediting the investigation but emphasized the fact that wherever possible the cooperation and assistance of individuals and companies will be solicited. It was suggested that possibly the fundamental studies might be carried on through fellowship arrangements, whereas the development of standardized tests would be accomplished largely through the cooperation of many individuals.

It was pointed out that no plans had actually been made for the solicitation, use, or administration of funds, although a preliminary questionnaire was circulated to all whiteware manufacturers and clay producers to guide any future action. The results of this questionnaire represent the opinions of the forty responses received.

There was almost complete approval of the objectives in their present conception, as disclosed in a foregoing section of this report and in a previous report.[3]

Seventy-five per cent of all replies were favorable to financial support of a clay investigation, and the remaining 25% were equally divided between those whose usage of clay is too small to justify support and those who were not in a position to state company policy without further approval. It is particularly noteworthy that all ten ball clay and kaolin producers who replied were favorable to financial support.

This project undoubtedly will receive adequate financing provided a comprehensive program is planned which meets the approval of manufacturers and producers alike. Furthermore, the Bureau of Mines, various universities, and other research organizations have indicated a willingness to cooperate in every way possible. This type of cooperation may eventually be extremely helpful.

IV. Project Organization

G. A. Bole, who has had extensive experience in the development of A.S.T.M. standards, delivered the following interesting paper on "Organization of a Project Designed to Promote Standardization."

Bole Discussion

We have in the United States a wealth of variation in ball clays. A glance at the chemical analyses and physical properties of the thirty-three commercial ball clays for which the Committee has complete data leads one to question just how these relatively small deposits can best be used and how they can best be conserved.

It is interesting to examine the data submitted by the various producers from the angle of variation. In chemical analysis the clays vary, as shown in Table I.

TABLE I

CHEMICAL ANALYSES

	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	Alkaline earths	Alkalis	Ignition loss
High	60.70	36.30	2.45	2.82	2.05	2.43	17.4
Low	43.80	22.20	0.74	0.73	0.08	0.29	9.4

The physical properties vary between the limits shown in Table II.

TABLE II

PHYSICAL TESTS

	Water of plasticity (%)	Dry modulus of rupture (lb./sq. in.)	Dry linear shrinkage (%)	Total shrinkage (%)
High	61	931	11.3	24.3
Low	28	150	03.5	15.8

The Committee does not know how the samples were gathered, what laboratories made the tests, what methods were used, nor how the data were calculated. For instance, the value of 17.4 for ignition loss probably means that there was several per cent of organic matter in addition to the water of constitution. It suggests that we must have a standard method for determining the carbonaceous matter in these clays.

We should have a method for determining the free silica directly rather than by computation from the variable

[3] "Symposium II," *Bull. Amer. Ceram. Soc.*, **23** [2] 47–53 (1944).

mineral structures of these clays. We will have more trouble with the chemical analysis than with the physical tests, owing to the fact that we are not analytical chemists and, furthermore, owing to the prejudices of the better-informed chemists regarding the procedures used. It is a difficult job to separate an old analytical chemist from his method of procedure. Even such a simple thing as reporting the analysis is likely to cause difficulty. Some chemists will report a clay analysis on an air-dried basis, whereas others will report it on an oven-dried basis. The air-dried is a precarious basis for a report of an analysis but really has some significance in the case of the ball clays. The American Society for Testing Materials in its ceramic divisions has had more difficulty with the chemical analysis than with any of the physical tests. We will probably want to work out a method for showing the rate of drying of these clays under a standard set of conditions, as it is an important characteristic of a ball clay.

One of the prime characteristics of a ball clay is the grain-size distribution. Several methods have been suggested, but none has been set up as a standard. A compromise will likely have to be agreed upon, as the determination requires extreme accuracy and is time-consuming. From several angles, the writer prefers the Andreasen pipette procedure, but the work at the Massachusetts Institute of Technology will ultimately produce a method that is both accurate and reasonably rapid.

There has been some discussion as to whether the group should go ahead with a program of standardization at the present time or whether the clays should be studied fundamentally before proceeding with the development of standard tests. Standards are never static. They are always developed from present knowledge so must change as our knowledge grows. As new information is developed, our standards will be revised or changed entirely to meet the requirements of the new knowledge. The property of plasticity is one that will require considerable study in terms of fundamental research before a standard test can be written. It is clear that we need more and more fundamental study in the field of ball clays.

The methods decided upon as standard test methods will be more widely used if they are direct, simple, and inexpensive to make. The test apparatus must be generally available and should, if possible, be made by one laboratory. Dietert[4] has worked out procedures and devised equipment used in testing foundry sand. The test methods were formulated by the Sands Committee of the American Foundrymen's Association, and Dietert's work has been to the advantage of all concerned.

It would be advantageous if such an arrangement could be worked out with one manufacturer and distributor to make the laboratory equipment required in our standard tests. The accuracy of the data obtained would depend then solely upon the skill of the operator. Such mechanisms should be sold with a printed booklet describing the operation and care of the apparatus. This procedure is simply a suggestion that is worth considering until a better one is offered.

The Committee's first work is the standardization of a procedure for obtaining and preparing the samples to be used in the laboratory tests. We have had years of experience in the testing of clay—every one in his own way. Now we plan to work out procedures and devices that all will use.

We are not interested in classifying the clays. We want simply to furnish the producer and consumer alike with standard methods of test. It is the purpose of the Committee to gather the samples and distribute them to designated laboratories for test. The object of this preliminary work is to prove out the test methods rather than to gather data on the ball clays, although that will be a useful by-product. When this work is completed, these test methods will become standards of The American Ceramic Society. That, however, is only the beginning of the long-term program. The data so obtained will be the basis upon which specifications can be written and around which a program of conservation can be worked out.

Whether we will ever be interested in having, or can have, these standards set up in the A.S.T.M. or A.S.A. is problematical. R. E. Hess of the A.S.T.M. office, in answer to an inquiry, makes the following statement:

"A.S.T.M. standards and A.S.T.M. committee activities apply particularly in cases where a product can be processed to conform to specifications. I understand that in recent years this is being done in connection with clays. In other words, it is not merely a question of accepting the product as it is quarried, but it is actually processed to conform to certain requirements."

A committee consisting of both producers and consumers should be set up as agreed upon. This committee should be composed of an equal number of producers and consumers, and, in addition, there could be general-interest members such as the university group, if desired. The committee should be large enough to provide a correct cross section of the best thought and experience on the subject and yet not so large as to be unwieldy. If a large committee seems necessary, it might be well to have an inner group known as an advisory committee. Various subcommittees would be in charge of research, tests, and specifications, with subsections on the individual tests. Committees on precision and tolerance, definitions, editorial, etc., might be formed as the need arises.

A pattern similar to that set up by the A.S.T.M. and the A.S.A. should be followed. In these organizations, each test method and each specification is accepted as tentative and tried out for a period. It is then advanced to standard after the trial period, revised, or dropped. Standards can be revised or withdrawn upon vote of the committee.

Rules regarding the election to membership and tenure of office must be considered. It is thought best to extend membership on such committees over a reasonable period, as the member's value to the committee increases as his familiarity with the procedures increases.

The committee must decide upon the minimum number of tests that will evaluate the prime characteristics of a ball clay. The laboratory procedures used will result from a study of the various procedures and devices suggested by the committee. Should the clay be tested without dilution, should a standard body be used or the clay be blended with potter's flint or other agents, and should the sample be deaired or the test run on an undeaired sample? These are all points that must be clarified and defined. Ball clays have many uses. If we are thinking in terms of ceramic usage alone, the designation of the standard and specification should be so defined.

The accuracy of the data secured will depend upon the committee as well as upon the laboratories to which the work is given. A close supervision of the work must be assured. The work should be checked by different laboratories, using the same devices and procedures. This is hardly a job for undergraduates.

The specifications should be simple, requiring as few test methods as will truly evaluate the clay. As stated before, costly apparatus should be ruled out except when no simple piece of equipment will tell the story. The procedures should be simple and rapid. The utility of a standard is lessened if it fails to meet these requirements. The cost of running a test will be a measure of its utility. The tests, however, must be conclusive and evaluate the product or they are not standard tests and can never be used as a basis for specifications.

We have talked in generalities long enough and should proceed very soon to the organization of this committee, making it responsible for blending the mass of suggestions now available into a crystal-clear procedure. Such a start need not be the final structure nor static as to personnel.

[4] H. W. Dietert, "Chart Data on Molds and Core Surface Behavior at Pouring Temperatures," *Amer. Foundryman*, **5** [10] 2–5 (1943); *Ceram. Abs.*, **23** [1] 7 (1944).

V. Variations in Plastic Character

A paper entitled "Variation in Plastic Character of Different Ball Clays" was presented by *A. S. Watts*.

Watts Discussion

The character of the plasticity of ball clays is not capable of evaluation, probably because it is due to several factors in all cases. The grain size, the presence of alkali on the surface of the clay particles, and the associated humic acid and vegetable tissues are probably the greatest factors in producing the plasticity, and perhaps its character could be determined if we knew the proportion and activity of each. Particle size, however, involves the matter of particle shape, although all evidence points toward spherical particles as predominating in ball clays. We know that the particle sizes vary and that some ball clays are extremely fine whereas others are almost as coarse as some of the china clays or kaolins. Study of particle aggregates suggests that the most effective combination of particle sizes occurs when the particles combine to leave the minimum of unoccupied space, but whether this would promote plasticity has never been decided because other factors always prevent a study of this factor independently. The second consideration, which involves the alkali present, would include the H_2O present and would be influenced by the association of alkaline earth hydrates with the alkali hydrates. We know that the alkali hydrates produce a greasiness or slipperiness of the solution with little evidence of stickiness, at least in dilute solutions. The similar character of alkaline earth hydrates is also recognized, but we have no data on the action of these latter independent of the alkalis in the H_2O solution which envelops the ball clay particles. Also, we know that both alkalis and alkaline earth in hydrate form exist as adsorbed salts and penetrate into the particles, resulting in some swelling.

We also know that, in general, the presence of acid salts promotes plasticity, and it seems logical that these would tend to neutralize the alkalis according to the laws of chemistry. Apparently, however, the humic acid, as well as sulfate and acetate solutions, adds to the plasticity and operates in an additive manner without direct reaction with the alkalis. The influence of humic acid, which dissolves in dilute alkaline solutions and forms a sticky rather than a greasy solution, is an important factor in the plasticity development of the dark ball clays. The vegetable tissues function through the liberation of this gelatinous hydrocarbon material, but whether the vegetable acids penetrate the ball clay particles or whether their action is merely a surface phenomenon is not reported.

Finally, we do not know whether these various factors are completely additive or whether they to some degree neutralize one another, perhaps tending to either break down the particles into smaller units or causing them to unite to form larger aggregates. The evidence obtained by a study of various so-called ball clays may furnish some clues to the answer. English ball clays, whether light or dark, normally contain more adsorbed alkalis than American ball clays, and the characteristic of greasiness is more apparent in English ball clays than in American ball clays. Also, the dark English ball clays display as high a bonding strength as the dark American ball clays which contain the same amount of hydrocarbon material and approximately the same ratio of humic acid to vegetable tissues so that the increased amount of alkali which is present in the English ball clays apparently has little effect on the dry strength, although it is recognized as promoting greasiness which is evidenced by less resistance to forming pressure. The particle sizes of the English ball clays are apparently similar to those of the American ball clays of like character, so that this factor is probably not involved.

We find, however, that materials known as ball clays may exist which are distinctly different from the recognized ball clays normally employed. In some deposits, material is found which is highly plastic but of distinctly greater particle size than the normal ball clays and has less drying shrinkage and generally less firing shrinkage than the normal ball clays. Ball clays (so-called) are also found like the Mississippi ball clays which are of extremely minute particle size and which contain relatively little organic material. These clays, due perhaps to the grain size, furnish satisfactory bond for about an equal amount of nonplastic but do not parallel the ball clays.

All of this indicates that plasticity as evidenced by greasiness or stickiness, or both, should not be confused with particle size unless the cohesion of the particles can be definitely correlated with the thickness of the H_2O envelope at some definite stage of drying. The hope of such correlation is remote and, aside from the particle-size consideration, we have only the presence of some sort of organic bond and soluble alkalis. If this organic bond is reacted on by the soluble alkalis present in the ball clay, we may have a reaction not unrelated to the process involved in the development of soap mixtures where the alkali combines with the organic material to form a stable jelly. In any event, the H_2O of plasticity consisting of envelope H_2O and pore H_2O or interstitial H_2O is merely an indicator of the demands resulting from (*a*) particle size, (*b*) organic material demand based on degree of swelling or possibly alteration of the vegetable matter, and (*c*) hydration of the alkali to the most favorable dilution for the development of bond. Since the H_2O involved gradually decreases as drying progresses, we must have a progressive change in the bonding characteristics of both the organic and the alkali content. Correlation would require a definite stage of drying, or at least a definite ratio of H_2O or some property to the unit mass of clay. As the particle size, the amount and character of the organic material, and the amount of soluble alkali present differ with every ball clay, and probably differ in different portions of the same deposit, the only possibility of providing a basis for correlation appears to be some physical state or perhaps a physical property without a clear statement of what constitutes plasticity.

Any value chosen will be subject to criticism, but, since we are considering the bonding power and the molding properties as the primary properties of ball clays, either of the following is suggested as a basis for standardization:

(1) Bonding power could be based on the amount of H_2O necessary for the development of a mixture which would retain a cubical form under a standard condition of vibration; the method of test would be to place the cube, which is molded to exactly one cubic inch, on a vibrator operated by a cogwheel giving 500 vibrations per minute. This would be more uniform in its action than the Atterberg V-shaped groove which is tapped with the hand. The test would last for one minute, and the vibrator could be operated by belt or direct motor. Such a test should include a definite procedure in preparing the cube, and the following is suggested: 25 grams of pulverized clay are stirred into exactly 15 cc. of distilled H_2O at the rate of one gram per minute until a thick mud is produced, then one-half gram of clay is added at one-minute intervals and spatulated to insure uniform distribution. When the desired physical state is approached, the clay is molded in a one-inch cube mold placed on an oiled paper and the top is smoothly struck off with a spatula. The cube is expelled without reversing the top and bottom of the cube. It is then transferred to the vibrating plate and the test is conducted as indicated. By modifications of the clay-water ratio, we can arrive at the proportions which provide the maximum water content possible without development of distortion under vibration.

(2) Molding properties could be evaluated on the basis of clay flow under known pressure. The writer favors vertical flow from a cylinder of definite dimensions through a die of definite opening and length. Thus frictional resistance would be constant and the only variable would be resistance of the clay mass to change of form. Possibly the penetration test of Edward Schramm, the American Refractories Institute cold-set mortar test, or the sticky-point test proposed in the 1943 symposium would be equally satisfactory (see February, 1944, *Bulletin*, p. 52).

Another consideration in the testing of ball clays involves the amount of free silica in the ball clay. We know that all ball clays contain free silica and, if we calculate the

combined silica on the basis of the kaolin formula, we find that the free silica residue varies from 6 to 33%. No definite relationship is evidenced between the calculated free silica content and the dry properties of the clay, hence we must conclude that the variations in water of plasticity, drying shrinkage, and dry strength are due to other causes than the clay-free silica ratio. It would seem highly desirable, however, to develop a test in which the amount of free silica would be approximately constant.

To arrive at the amount of free silica in the clay, a sample other than that used for the standard tests could be deflocculated with NaOH and the clay suspension decanted away. The crystalline content would be dried and weighed. Calculating this as free silica, we would then add to the clay to be tested enough pulverized flint to produce a 50 pure clay-50 free silica mixture. The comparison of such mixtures should be highly instructive, as only the variations in composition of the clay essential would be involved. The only uncertainty in such a procedure would be whether the clay essential in the ball clays studied was in all cases the same kaolin mineral.

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Dr. Speil suggested that the thermoanalysis method might be used successfully for the estimation of the free silica content of ball clays, and this was found to concur with several proposals previously received by the Chairman.

Professor Watts pointed out that his proposed method of estimating the free silica content of clays by deflocculation and decantation is by no means unequivocal, but that it might serve as a useful starting point. *Dr. Schramm* suggested that the method might properly be described as a means of separating colloidal and noncolloidal particles. *Professor Watts* agreed that this is logical and that some of the silica would be so fine as to be a part of the colloidal fraction. He reported unusual success in testing clay-flint mixtures when compensation was made for the free silica content as estimated from the test procedure in question.

Mr. Thiess suggested that possibly the chemical analysis would be more suitable as a basis for computation of free silica content, but *Professor Watts* cited the inadvisability of doing this due to the complication which is introduced by the mica content of all ball clays.

The probable effect of particle size of the free silica removed by the decantation method, as compared with that subsequently mixed with the clay to obtain a required clay-flint ratio, was cited by *C. M. Dodd*. *Professor Watts* stated that, although such shortcomings are inevitable, the method has permitted a much more intelligent vision of various ball clays than he had ever attained otherwise.

VI. Ball Clay Test Methods in Current Use

Lambe Report

C. M. Lambe, Jr., presented the results of a questionnaire sent by Dr. Russell to some 400 producers and users of ball clays. Table I shows the breakdown of the returns with respect to primary use or interest. Table II is the analysis of results to the question, "What tests are you now using on ball clays?" Tables III and IV analyze respectively the questions, "What tests would you use if standard methods were available?" and "What tests would you desire that the producers perform?"

Mr. Lambe pointed out that the companies fall into two general classes, one class carrying on a preponderance of all tests and the other class conducting only a very few tests or none at all. The fact that a number of manufacturers do absolutely no testing of ball clays is noteworthy. The popularity of different tests varied according to the end use of the ball clay, and the figures in Table II must be examined with due consideration for the preponderance of the total reports which came from some fields as indicated in Table I. It is surprising to note that only 38.1% of all manufacturers make any actual moisture determination despite the fact that the ball clay as used often contains more than 25% moisture. Those tests which would be most desired (Table III), if standard methods were developed, include pH determination, particle size, castability, plasticity, and soluble salt content.

TABLE I

DISTRIBUTION OF RETURNS

Ball clay users returning questionnaires: 10%.
Divided as follows:

	(%)
Dinnerware manufacturers	33.2
Sanitary-ware manufacturers	9.5
Refractory porcelain	7.2
Electrical porcelain	9.5
Government agencies	7.2
Tile manufacturers	16.6
Ceramic material producers	2.4
Educational institutions	7.2
Art pottery	2.4
Steatite and dental porcelain	4.8
	100.0

TABLE II

TESTS NOW BEING PERFORMED

Test	Determined by (%)	Percentage of total tests performed
Moisture content	38.1	10.4
Screen tests for lignite	14.3	5.9
Fired shrinkage	38.1	10.4
Fired absorption	38.1	10.4
Fired color	54.8	14.9
Linear drying shrinkage	45.2	12.5
Linear firing shrinkage	11.9	3.2
Dry modulus of rupture (50% flint)	31.0	8.5
Fired modulus of rupture (50% flint)	11.9	3.2
All tests on normal body	2.4	0.6
Sag tests	2.4	0.6
Warpage	4.8	1.2
Particle-size determination	2.4	0.6
Casting rate	2.4	0.6
Screen analysis	7.2	1.9
Fired porosity	9.5	2.4
Water of plasticity	9.5	2.4
Chemical analysis	4.8	1.2
Firing range	2.4	0.6
Pyrometric cone equivalent	4.8	1.2
Iron tests of various kinds	4.8	1.2
Ignition loss	7.2	1.8
Total shrinkage	4.8	1.2
Effect of electrolytes	4.8	1.2
Viscosity when made into a slip	4.8	1.2
No tests	2.4	0.7
		100.0

TABLE III

TESTS DESIRED

Test	Would be run by (%)
pH determination	16.7
Soluble salt determination	7.2
Reaction to electrolytes	2.4
Particle-size tests	11.9
Dialysis	2.4
Castability	11.9
Filter-pressing behavior	2.4
Plasticity	9.5
Chemical analysis	2.4
No further tests desired	26.2

TABLE IV

DATA DESIRED FROM PRODUCER TESTS

	(%)
Impurity content	2.4
Soluble salts	2.4
Vitrification behavior	2.4
Glaze application	2.4
Crazing tendency	2.4
Shock resistance	2.4
Moisture content	9.5
Green strength (50% nonplastic material)	7.2
Fired absorption	4.8
Particle sizes and their distribution	16.7
Strength alone	2.4
Fired porosity	2.4
pH	2.4
Dialysis	2.4
Chemical analysis	14.3
Mineralogical composition	9.5
Screen tests	2.4
Color	2.4
Deflocculation characteristics	2.4
Shrinkage in drying and firing	2.4
Plasticity	2.4
Percentage of nonplastic material	2.4
Castability	2.4
All the above properties and anything else	11.9
Nothing	11.9

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G. W. Phelps reported the test procedures used by one representative ball clay producer:

Phelps Report

To insure adequate control of the clay mines and, incidentally, to render mining easier, our ball clays are in effect tested three times. By means of prospect holes, a promising spot is selected and the ground is rebored on 50-foot centers. The clay types are separated and tested. If the results of these tests prove out, the stripping operation is begun.

The stripped-over clay is then again rebored, this time on 10- or 15-foot centers, to determine the quality and quantity of clay to be expected and to guide the mining superintendent in his operation.

This same procedure is followed each time the clay bank is stripped back 50 or possibly 100 feet.

During the course of mining, grab samples are taken from each truck and combined into a single sample for a given lot of clay. The clay is divided into 100-ton lots, which are stored in numbered sections of a storage shed. The grab samples are combined and eventually amount to about 100 pounds. This material is broken down to 1-inch size and is quartered down to a 5- or 10-pound working sample. Each lot is given a number which also appears on the sample.

Insofar as possible, we attempt to follow our routine testing procedure for all samples, but it is impossible to do much testing with a hand-auger sample from a 6- or 12-inch clay seam.

A pH check is run on each sample. A 20% suspension of clay in distilled water is allowed to stand for 24 hours with periodic shaking. With ball clays, it is impossible to use supernatant liquid for pH tests because of incomplete settling. To obtain consistent readings, it has been necessary to introduce a small amount of saturated HCl solution into the test dish or beaker. A Beckman pH meter with glass electrode is used for the pH measurement.

Each of these mining samples is also tested for particle size by the use of a modification of the Robinson pipette, the Andreasen pipette, or occasionally the hydrometer. All three methods correlate satisfactorily.

Screen analysis is particularly difficult for ball clays, as the boring sample obtained by the hand auger is not entirely suitable because of possible lignite concentration. A 2- or 3-pound sample, however, is washed through 200- and 300-mesh sieves. This method at least provides some idea of the finer portions of the residue.

Whenever possible, we make two sets of specimens for the raw physical and the fired physical properties. One set is made from 100 clay and the other from a 50 clay–50 flint (200-mesh) mixture. Moisture compensation is used in preparing the clay-flint mixture.

In preparing samples, the clay is first broken to pass a 4-mesh sieve and the clay-flint mixture is flooded with 150% of its weight in moisture. The resulting slip is then passed through an 80-mesh sieve and dried fairly rapidly. The plastic mass is then hand-wedged and extruded into round 6-inch bars.

The clay is extruded on an oiled palette, which has previously been weighed, and the 6-inch lengths are cut with a wire. The palette and bars are weighed, and the weights of bars are recorded.

Each bar is immediately marked with 5-centimeter shrinkage marks and identification numbers. The bars are allowed to harden or dry for from 24 to 48 hours and are then turned. They are allowed to stand for another 24 to 48 hours without turning and then are transferred to the top of a drying oven where they are further dried at about 40°C. for from 12 to 18 hours. At the end of this time, they are transferred to the interior of the drier where drying is completed at from 90° to 95°C. in 4 hours.

Rather than cool the bars in a desiccator, the heat of the drier is reduced to about 40°C., and weight, shrinkage, and modulus of rupture tests are made on specimens taken directly from the drier. The broken bars are again marked with 5-centimeter shrinkage marks and fired at cones 8 and 11. These firing temperatures have been chosen because most domestic ball clays vitrify with an accompanying color change between cones 8 and 11. A semidirect gas-fired kiln and an identical schedule is maintained at all times.

The use of round bars has permitted the preparation of a chart which reduces the total time for breaking and calculation from about 4 minutes to 1 minute per bar.

Drying shrinkage calculations are based on the plastic length and firing shrinkage on the dry length. Absorption is determined after a 2-hour boil and 24-hour soak.

Chemical analyses are made periodically, depending upon the extent of mining a particular deposit. Soluble salt tests are now in the process of development.

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Ball clay test methods and control were also discussed from a producer's viewpoint by *R. C. Meeker*.

Meeker Report

The most common tests for ball clays used in whiteware bodies are those which determine such properties as the amount and type of residue on a 120-mesh and other screen sizes, water of plasticity, linear dry and fired shrinkage and absorption at different firing temperatures, fired color, dry strength, reaction to electrolytes, casting rate, and drainage.

Specimens for firing are made from clay lawned through 120-mesh, dried to proper consistency in plaster molds, hand-wedged, and pressed into plaster molds to produce a specimen 100 mm. in diameter and 5 mm. thick. These disks are used for linear shrinkage and absorption measurements and when glazed indicate the cleanliness of the clay being tested. Linear shrinkage measurements are also made on bars 1 by 1 by 7 inches; the shrinkage values of course differ from those obtained from the disks. Actual linear shrinkage depends upon the shape and size of the specimen.

Absorption tests are made from specimens broken to expose fractured surfaces by soaking in water for 24 hours. This seems as satisfactory as boiling in water for 2 hours and weighing when cool.

Dry strength tests using straight clay are no longer made. The weaker clays may show drying cracks and the stronger, more plastic clays may laminate. Equal amounts of 20-mesh clay and potter's flint on the dry weight basis are used. The flint shows a residue of approximately 0.8%

on a 200-mesh sieve. Water is added to the mixture of clay and flint to produce a slurry of about the same consistency for each clay tested. The water content is never less than 62½% of the total batch. The slurry is mixed for a few minutes with a small electric mixer, allowed to stand for 3 hours, dried to proper working consistency, hand-wedged, and pressed into a brass mold with a removable bottom to form a 1- by 1- by 7-inch bar. The bars are dried under cover for two or more days, turned to equalize drying as much as possible, and air-dried for at least one more day. They are then oven-dried at 70°C. until there is no condensation when representative bars are placed on a metal surface. They are then dried for 4 hours at 110°C. and cooled in a desiccator. The bars are broken on a 5-inch span with the sides of the bars on the supports to minimize the effect of any laminations. This also gives a better bearing surface at the supports. The weight is applied directly with shot at the rate of approximately 100 pounds per minute.

The Casagrande method is used for grain-size determinations. Only one procedure in this test may differ from practices ordinarily followed: the clay after blunging is lawned through a 325-mesh sieve and the fraction retained is thrown into the coarsest fraction of the determination. It should not be assumed, however, that grain-size determinations are regularly and frequently made as a test and control method.

A standard casting body containing 26% ball clay with china clay, flint, and feldspar and a definite amount of water is used to determine the reaction to electrolytes, the viscosity at which drainage can be maintained, the wet and dry weight of the cast, and the type of cast (short or plastic). The specific gravity of this standard body will vary, due in part to the difference in the specific gravity of ball clays, and there may be other influencing factors. Soda ash and N-brand sodium silicate are the electrolytes. The bodies after mixing are lawned through a 120-mesh sieve. The viscosity is measured by timing the flow of 200 cc. of slip through an open-top viscosimeter with a $^{5}/_{32}$-inch orifice. A twin tapered bar mold is used to compare the same grade or two different grades of ball clay. The slip is cast for 17 minutes with a 3-minute draining period; then the mold is stripped. Drainage is noted and the dry and wet weights of the cast are recorded. No two grades of ball clay will show the same reaction to electrolytes. Slips and bodies in which certain ball clays are used will hold draining properties at relatively high viscosities, whereas bodies in which other ball clays are used must be brought to lower viscosities for proper drainage. Ball clay which may be quite suitable for casting in low specific gravity slips may not be satisfactory in slips of higher specific gravity.

Testing of ball clays aids control, but the uniformity of carload shipments depends to a great extent on (1) the uniformity of the deposit and (2) the skill and judgment of the mine superintendent, foreman, and miners.

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Dr. Russell offered the opinion that the two foregoing discussions by producers indicate they are doing just about everything possible with the tools at hand to control their materials. Neither they nor the manufacturers would object, however, to faster and more indicative methods of control which it is hoped will result from this investigation.

J. R. Beam then discussed ball clay test methods from a manufacturer's viewpoint obtained through experience in a company which places a premium on the testing and understanding of its raw materials. He also presented mimeographed copies of their test procedures which are included herein following his remarks.

Beam Report

This discussion will be confined to the benefits of raw material test procedures in a plant which uses ball clays in the manufacture of sanitary ware by the casting process.

Everyone in this organization is interested in raw materials. If the raw materials are not right, the sliphouse cannot function as it should, the casters cannot cast with the assurance of obtaining quality ware, and so on through the plant. As so many people are interested, it is only natural that we want to talk the same language. Also, when discrepancies occur, as they so often do in ceramic materials, complete details on the procedures are necessary.

The problem involves more than a series of readings. At the present time, we cannot place a man on checking raw materials and solve the problem. As soon as he is trained, he may be inducted into the armed services or may be transferred to another part of the plant.

We must have a procedure, therefore, which several men can follow to obtain the same results.

Ball clay tests are absolutely necessary for plant control. When a carload of clay is received, we must decide in a short time whether to process the clay or not. One common method of evaluation is to try the clay in commercial production. If the clay causes trouble, it is known to be different. A preferred method, however, is to make so-called isolated tests. Thus, instead of a commercial and possibly costly application, it is possible to determine the desired information without any manufacturing risk.

We are interested in one thing. Is the shipment of clay the same as the last one? If not, wherein is it different?

Two types of tests can be arranged: (1) Physical tests on the cleaned washed clay, such as shrinkage, moisture, grain size, viscosity, modulus of rupture, absorption, and warpage. (2) A chemical analysis of the filtrate from the clay; as clay is colloidal in nature, variations in the soluble salts decidedly affect the working qualities of the clay.

Our plant program was started ten years ago (November, 1934) and, as new procedures were developed or modified, the detailed specification was revised. During this time, many men have followed the procedures and, with few exceptions, after a month or so of concentrated effort an analysis comparable to the others can be made.

The biggest advantage of the program is the fact that someone is making a regular routine test on the material. We are not interested in the fact that one car has a shrinkage of 16.0% and the next car has a shrinkage 0.2% higher.

After we have made a series of tests and have two analyses before us, how do we determine which clay is good, which clay is bad, or whether the clays are the same? Many times the laboratory assistant who makes these tests will report that the clay is different. He has found that the small details of the routine are different and thus yield different figures. This has a direct bearing on the present discussion. In other words, the tests we have outlined are not complete enough to bring out all the details and no one as yet has suggested improved tests.

An experienced laboratory assistant will form his opinions on a clay analysis from the general working properties after he has completed his routine tests. He can tell whether the clay is a good average sample from the mine or the cleanup of a bin and whether the clay was stored in the open or under cover.

The laboratory assistant can discover many other discrepancies just by his over-all analysis from following a definite routine. Peculiarly enough, if an excellent laboratory analyst and an excellent slipmaker are combined in the same man, he can generally run a poor clay through the plant without any shop trouble. In other words, he can determine the differences in a clay and make allowances for them in the sliphouse, so that the difficulties are eliminated by the time the caster uses the slip.

Clay producers are interested in delivering as uniform and good a product as possible. If trouble develops in a clay deposit and the clays reach the customer, the customer invariably gets into trouble. Too often the reverse is true. The user gets into difficulty and blames the clay. If the routine analysis does not indicate any peculiar conditions, it is much better to examine the processing operations or drying conditions within the plant.

The writer recently reviewed the analyses of 284 cars of clay received from one deposit over an 8-year period. The analyses are surprisingly close and provide a renewed assurance that for some of the larger deposits real benefits

can be derived by following a definite schedule of testing.

The following outline of some tests used on raw materials for sanitary-ware manufacture may be of interest.

PURPOSE AND SCOPE

The uniformity of ceramic raw materials is determined by repeated testing in a known routine procedure. The following test procedures are designed to indicate the trends in batch-to-batch samples and give relative comparisons in the judgment of ceramic raw materials.

Two types of tests are involved: (*a*) physical tests on the cleaned washed clay and (*b*) chemical tests on the filtrate from the filtering process checking the soluble salts washed from the clay.

The tests are written in a brief style to allow an average workman to follow the procedure. Deviations from the procedure can be easily checked.

The apparatus necessary to make the determinations has been kept well within the requirements of the average ceramic laboratory.

References

(1) "Report of Standards Committee, American Ceramic Society," *Jour. Amer. Ceram. Soc.*, **11** [6] 335–534 (1928).

(2) Hewitt Wilson, Ceramics—Clay Technology. McGraw-Hill Book Co., Inc., New York, 1927. 296 pp.; *Ceram. Abs.*, **6** [11] 547 (1927).

(3) Standard Methods of Water Analysis. American Public Health Association, New York, N. Y.

(4) Heinrich Ries, Clays, Their Occurrences, Properties, and Uses. John Wiley & Sons, Inc., New York, 1927. 613 pp.; *Ceram. Abs.*, **6** [10] 485 (1927).

(5) Bernard A. Keen, "Physical Properties of the Soil."

Raw Material Test of Clays (Standard Specification 750, June 2, 1940)

(*a*) Obtain approximately a 15-pound sample of the material to be tested by the best method of sampling.

(*b*) Determine the moisture content on the dry basis.

(*c*) Weigh out a sample of dry clay equivalent to 10 pounds of dry clay and add distilled water to make a total of 35 pounds.

(*d*) Allow the mixture to slake overnight in the laboratory mixer.

(*e*) Mix for 5 hours and screen through a 60-mesh sieve.

(*f*) Wash tailings thoroughly and weigh residue on a 60-mesh sieve.

(*g*) Determine specific gravity, viscosity, and temperature of the screened slip, making sure there is no settling in the container.

(*h*) Take out 400 ml. of the slip for pH and acidity determinations.

(*i*) Filter-press the slip to a good plastic condition and take a sample of the filtrate for analysis.

(*j*) Wedge the filter-press clay thoroughly until the mass has the consistency of soft putty.

(*k*) Make up 3 small pats and obtain wet weight for the moisture determination.

(*l*) Make up 20 bars approximately 7 inches long on the extrusion machine. Mark 5 for shrinkage determinations and save the other 15 for dry and fired modulus of rupture determinations.

(*m*) Dry bars and pats thoroughly in an oven at 110°C. and cool to room temperature in a desiccator.

(*n*) Weigh pats and determine dry weight from which "water of plasticity" can be calculated.

$$\frac{W - D}{D} \times 100$$

(*o*) Determine the dry modulus of rupture and drying shrinkage on bars.

(*p*) Fire pats and determine their fired weight for ignition loss determination.

$$\frac{D - F}{D} \times 100$$

(*q*) Fire bars on the middle deck of the tunnel kiln and determine fired modulus of rupture and fired shrinkage.

(*r*) Record above data in laboratory data book.

Moisture Determination (Standard Specification 269, June 5, 1937)

(*a*) Obtain a 5-pound sample of the material to be tested. This sample is to be taken with due regard to obtaining a sample representative of the moisture being measured.

(*b*) Weigh out a 1000-gram sample immediately, or before any drying takes place in the sample.

(*c*) Dry the 1000-gram sample at 110°C. until thoroughly dry. Weigh the dry sample and record the weight in the data book.

(*d*) Again dry the sample for one hour and reweigh. If the weight as first recorded is the same as the second weight the sample is dry.

(*e*) Record the dry weight. Subtract the weight of the dry sample from the weight of the wet sample or 1000 grams. Divide the difference by the weight of the dry sample and record the moisture loss as per cent on the dry basis.

(*f*) Report these results on the daily control report.

Shrinkage Determination on Slip (Standard Specification 271, June 5, 1937)

(*a*) Dry the shrinkage molds to constant weight.

(*b*) Pour 3 molds full of the slip under test and allow to cast until set up solid.

(*c*) Do not allow the spare to empty entirely. Add slip every 30 minutes until the bar stops casting.

(*d*) Four hours after the bar is poured, open the mold and mark the bar for shrinkage determination.

(*e*) Allow the bar to dry in the open air for 24 hours, then finish drying in the oven at 110°C.

(*f*) Record the drying shrinkage on the wet basis.

(*g*) Fire the bar through the kiln and record the total shrinkage.

(*h*) Take the average of 3 bars for the exact shrinkage to be reported.

Shrinkage Determination on a Ceramic Raw Material (Standard Specification 751, June 2, 1940)

(*a*) Make up 20 bars approximately 6 inches long on the extrusion machine.

(*b*) Mark 5 bars exactly 100 mm. apart with the pointed ends of a vernier caliper.

(*c*) Allow the bars to dry 16 hours in the open air and then finish drying at 110°C. in a radiant-heat oven.

(*d*) The wet length minus the dry length times 100 divided by the wet length gives the shrinkage on the wet basis.

(*e*) Fire the bars through the kiln, measure, and record the fired and total shrinkages.

Grain-Size Determination (Standard Specification 625, March 25, 1939)

(*a*) Obtain a 1000-gram sample of the material to be tested and dry thoroughly at 110°C.

(*b*) Weigh out exactly 200 grams in each of the following 8-inch diameter laboratory screens: 100, 150, 200, 270, and 325.

(*c*) Screen the sample by gently washing under running tap water. Make sure the tap water is free from granular contamination. Put a screen-cloth filter over the end of the tap if there is a possibility of contamination.

(*d*) Wash the screen gently by rolling back and forth over the screen surface until the water runs clear for 5 minutes and no further breakdown is noticed.

(*e*) Dry the screens thoroughly at a temperature which will not corrode the screen cloth.

(*f*) Do not shake the screen after drying before taking weights. Weigh up the screen residue and subtract all coarser grain totals from the weight under determination.

(*g*) Divide all readings by 2 so they will be on the basis of per cent rather than on the 200-gram sample.

(*h*) Record the following data on the daily control report: (1) card number and name of material and (2) date tested and car number.

*Per cent on 100-mesh
Per cent on 150-mesh Per cent on 270-mesh
*Per cent total on 150-mesh *Per cent total on 270-mesh
Per cent on 200-mesh Per cent on 325-mesh
*Per cent total on 200-mesh *Per cent total on 325-mesh

NOTE: The above items marked (*) are weighed up on the balance; all others are obtained by subtracting from the following total.

Specific Gravity Determination on Clay-Water Mixtures (Standard Specification 753, October 25, 1941)

(*a*) The specific gravity determination is to be made in a 100-ml. pycnometer which has been previously standardized in the following manner.

(*b*) Weigh and record the weight of the dry bottle and stopper.

(*c*) Fill the bottle with water at 60°F. and weigh bottle, water, and stopper, recording the total weight.

(*d*) Repeat the above procedure using water at 70°, 80°, 90°, and 100°F.

(*e*) Subtract the weight of the dry bottle and stopper from the total weights as obtained at the respective temperatures.

(*f*) Divide the differences or the weights of water at each temperature by the true specific gravity of the water at that temperature, as follows: 100°F. 0.99307, 90°F. 0.99502, 80°F. 0.99646, 70°F. 0.99799, and 60°F. 0.99904.

(*g*) Take the average of the five results as the true volume of the pycnometer.

(*h*) Specific gravity readings of clay-water mixtures are made by weighing the pycnometer full of the mixture under test, subtracting the weight of the bottle, and dividing by the volume of the pycnometer as determined above.

Viscosity Test on Clay-Water Mixture (Standard Specification 754, October 25, 1941)

(*a*) The viscosity test is made in an orifice viscosimeter with the orifice cap drilled with a No. 31 drill (0.1200-inch diameter).

(*b*) The viscosimeter is to be filled completely, to a head of $6^1/_2$ inches of the clay-water mixture.

(*c*) Allow 90 ml. of the fluid under test to flow out through the orifice.

(*d*) Record the time for the following 160 ml. of material to flow through the orifice by allowing a continued flow of 250 ml. Record only the time for the last 160 ml. to flow through the orifice.

(*e*) Record the temperature of the clay-water mixture immediately after making the viscosity measurement. Record both the viscosity in seconds and the temperature of the material.

(*f*) The hydraulic equivalent of the above determination is 17 seconds at 68°F.

The viscosity test on glaze or other more fluid mixtures is made similar to the above except that a viscosimeter with an orifice cap drilled with a No. 48 drill (0.0760-inch diameter) is used. The hydraulic equivalent of the glaze viscosimeter is 48 seconds at 68°F.

Rate-of-Cast Determination (Standard Specification 288, June 5, 1937)

(*a*) Dry the rate-of-cast molds to constant dry weight.

(*b*) Pour 3 molds full of slip under test and record the time of pouring.

(*c*) Exactly 30 minutes later drain the molds by turning the molds upside down. Allow to drain until dry enough to release from the mold.

(*d*) Trim the rate-of-cast glass to the line around the top, taking care not to trim off more than should be taken off.

(*e*) Dry the glass to a constant weight in a radiant-heat oven and record the weight of the dry glass.

(*f*) Renew the molds often enough not to introduce the factor of decreased rate of cast due to old molds.

(*g*) Best drying conditions can be obtained by following this procedure: cast 8:00–8:30 A.M.; in mold 8:30–9:30 A.M.; radiant-heat oven 9:30–10:45 A.M.

Test Cast (Standard Specification 543, July 2, 1940)

(*a*) Dry the test cast mold to constant dry weight.

(*b*) Pour test mold full of slip and allow to cast exactly 10 minutes.

(*c*) Pour off excess slip and allow to drain exactly 5 minutes.

(*d*) Cut out 3 round disks with a $2^3/_4$-inch diameter punch.

(*e*) Immediately weigh all 3 cutout pieces and take the weight of the 3 cast pieces as a measure of the test cast.

Modulus of Rupture Determinations (Standard Specification 752, October 10, 1941)

I. CAST BARS

(*a*) Cast sufficient dry modulus bars in the regular 1- by 1- by 6-inch bar molds.

(*b*) Dry the bars under room conditions for 8 hours and turn them over 180° and continue to dry for 8 hours under the same room conditions.

(*c*) Place in oven and dry completely under radiant lamps.

(*d*) Cool to room temperature in a desiccator.

(*e*) Check breaking machine for zero balance.

(*f*) Insert bars on a 5-inch breaking span and break by adding shot at a rate of 100 pounds per minute.

(*g*) Discard all results on bars which do not fracture in a clean uniform break.

(*h*) Measure the width, *b*, and the depth, *d*, of the bar at the break (to the nearest 128th inch) by reading the vernier scale on the calipers. Convert to decimal equivalent according to the accompanying table.

(*i*) Calculate the modulus of rupture by the following formula:

$$S = \frac{3\,Pl}{2\,bd^2} \text{ or when } P = 8w \text{ and } l = 5$$

$$S = \frac{60w}{bd^2}$$

II. EXTRUDED BARS

(*a*) Take the 15 bars made up in accordance with section (*l*) of Standard Specification 750 and dry under room conditions for 16 hours. Completely dry in oven under radiant-heat lamps.

(*b*) Cool in a desiccator and break in the previously balanced breaking machine.

(*c*) Calculate the modulus of rupture by the following formula:

$$S = \frac{8Pl}{\pi d^3}$$

$P = 8w$
W = weight (lb.)
d = diam.
l = span (in.)

III. FIRED BARS

(*a*) The modulus of rupture on fired bars is calculated the same as above except that the span is increased to bring the bars within the breaking capacity of the machine.

Absorption Determination on Fired Ceramic Compositions and Raw Materials (Standard Specification 348, November 20, 1937)

(*a*) Obtain representative fired samples.

(*b*) Break edges to insure no surface imperviousness.

(*c*) Weigh each dry sample and record weight in data book.

(*d*) Place samples in autoclave and subject to steam at 100 to 120 lb. per sq. in. for 3 hours.

(*e*) Release the steam and fill the autoclave with water.

(*f*) Remove the samples from the autoclave and place immediately in a container of distilled water.

(*g*) Boil vigorously for 2 hours or longer and cool by running cold water into the container.

(*h*) Remove the samples, wipe off the excess water with a damp towel, and weigh.

(*i*) The increase in weight in grams multiplied by 100 and divided by the dry weight of the sample is the percentage of absorption on the dry weight basis.

The apparent porosity is sometimes recorded instead of absorption and is calculated by taking the increase in weight in grams and dividing by the volume of the sample.

Warpage Determination (Standard Specification 272, June 5, 1937)

(*a*) Dry the shrinkage molds to constant weight.

(*b*) Pour 3 molds full of the slip under test and allow to cast until the bars are cast solid.

(*c*) Do not allow the spare to empty entirely at any time.

(*d*) Four hours after the bar is poured the mold can be opened and the bar trimmed.

(*e*) Dry the bar in the open air for 24 hours and then finish drying in the oven at 110°C.

(*f*) Place the bar on a clean warpage determination setter which is cut exactly 6 inches between supports.

(*g*) Fire the bars on the second deck of the tunnel kiln car.

(*h*) Measure the maximum vertical distance between a straight edge and the warped bar with an Ames dial. Record the results as thousands warpage per $4^1/_2$ inches.

(*i*) Record the results on the daily control report.

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Sidney Speil then presented a report by *Hewitt Wilson* describing "Ball Clay Test Methods in Current Use at the Electrotechnical Laboratory, Norris, Tenn."

Wilson Report

The test methods at Norris are in the development stage. Several years ago, a study was made of the typical domestic white-firing clays of all types, whether ball clays, kaolins, bentonite, or others which fired to near white. The conventional tests for shrinkage, strength, and pore space were made by a single trained operator who used improved equipment, including a small vacuum auger machine for round bars and an improved type of mercury balance volumeter. It was soon found that the hand-feel method of tempering was not adequate and that these properties could be controlled and duplicated only when the tempering water was also under control. In the last test series, therefore, a median water content was used in weighed amounts and care was taken to avoid losses by evaporation until the last data in the plastic condition had been taken. The water content used for a given clay was the median between the maximum and minimum determined in actual runs in the vacuum auger machine.

It was also found that a more complete understanding of the characteristic properties of a clay could be pictured by a series of mixtures of clay and flint from 100% clay to 100% flint than by a single mixture alone. Charts of such mixtures showing the water of plasticity, shrinkage water, pore space, and transverse strength for the plastic and dry condition and volume shrinkage, apparent porosity, and transverse strength for the fired condition indicated a method of grouping into characteristic classes. After the data for many types of clays had been collected and a correlation had been attempted, the difficulties of classification were shown by the fact that it was necessary to use, in the dry condition, a ratio between the pore water for 80:20 clay-to-flint versus the dry transverse strength for 40:60 clay-to-flint. And in the fired condition, it was necessary to use a ratio between percentage absorption and fired transverse for a fair classification of the kaolinitic types of clays.

Illustrations of the foregoing have been given by Wilson and Hixon.[5] Their study clearly indicated that better controls were necessary for accurate correlation of data by a single person and most certainly between different operators in different laboratories. Their suggestions still hold good, viz., "(1) standard clay samples of various types and a standard flint should be selected, (2) the standard clays should be check-tested by numerous laboratories, (3) data should be interchanged to note the variation among different operators, (4) the work should be done by trained operators who can check and recheck their own work, (5) a standard sensitive clay should be placed in each firing for a check on the fired strength (this is believed to be more accurate than firing to the same temperature or cone without an accurate check on the strength itself), (6) a porosimeter should be used for an accurate measurement of dry pore space instead of the usual water-of-plasticity-minus-shrinkage-water method, (7) pore space versus strength should be used to classify clays, with strength as the more important property, and (8) the triangular relationship between pore space, shrinkage, and strength should be studied further."

The Norris laboratory has been forced by war problems to suspend the study of clays, but it will continue work after the war not only on the study of test methods but also the electrokinetic clay research.

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Professor Watts described "Tests of Ball Clays at Ohio State University."

Watts Report

Ball clay samples have for years been received in 100-pound lots and air-dried to constant weight.

On the clay alone, we determine the water of plasticity by the Atterberg process of adding the water to the clay. A sample of the clay-water mixture at the point (3) adherence limit is dried and the slaking test is made according to the American Ceramic Society Standard. Another sample of point (3) mixture is hand-molded into a 7- by 1- by $^1/_2$-inch bar and dried, then fired to cone 10 in 24 hours. Drying shrinkage, firing shrinkage, and fired weight loss are recorded. Similar tests are generally made on 50 clay–50 flint mixtures.

Our standard procedure is to test the clay in a standard body comprised of No. 1 feldspar 12, No. 1 ball clay 25, No. 1 kaolin 8, No. 2 kaolin 20, and pulverized sand flint 35%. For this, the ball clay is first blunged in an electric agitator with enough water to make a thin slip, then screened through a 150-mesh sieve, making the amount and character of the residue a matter of record. The other ingredients are added, and the slip is agitated for one hour. All is passed through a 150-mesh sieve and air-dried to a plastic mass which will just take the details of the fingers when a small mass is squeezed in the clenched hand. This mass is aged for 24 hours in a closed stoneware jar. The plastic body is usually prepared in 15-pound lots and extruded through an International deairing pug mill into 1- by 1-inch bars. Of 25 bars thus produced and marked for shrinkage and identification, every fifth bar is weighed and air-dried with a record of water loss and shrinkage. The dry bars are divided into three lots, taking every third bar for a lot. One lot is broken for dry modulus of rupture, one lot is fired to cone 9 in 24 hours, and one lot is fired at cone 12. The shrinkage, modulus of rupture, absorption, and color are recorded and referred to the standard body. The broken dry bars are glazed with a single-fire porcelain glaze and the cones 9 and 12 biscuit bars are glazed with a fritted semiporcelain glaze and fired to cone 5 in 24 hours. The results are recorded in texture of surface and freedom from specks or discoloration.

This procedure is not adhered to with every class, as some modification is introduced nearly every year in our search for improvement. The procedure followed, however, is uniform for all clays studied by any given class and the data are always correlated with the standard body. In this way, the quality of work of any individual or group can be evaluated. We have been successful in producing data throughout a long period of years which

[5] Hewitt Wilson and Herschel Hixon, "Testing Whiteware Clays," *Bull. Amer. Ceram. Soc.*, **21** [11] 287–91 (1942).

show reasonable uniformity, although each new lot of ball clay will show slightly different property values.

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E. J. Weiss, working under the direction of Professor Watts, obtained data on "Some Physical Properties of Ball Clays" which he presented.

Weiss Report

A study was undertaken to disclose the correlation between test data on a few ball clays following exactly the same procedure in all cases. Each sample was representative of the stock, which was never less than 50 pounds.

Procedure

A 25-pound sample was selected and pulverized and the moisture content was determined.

Fifteen pounds of the dry clay were placed in a Simpson mixer and the rollers were set in motion. Distilled water was added gradually until the clay mixture attained a wetness which showed slight sticking to the rolls. The rolls were cleaned and then run again to make certain that the sticking to the rolls was not due to any water splashing upon them. When the clay stuck to the rolls, a small quantity was taken from the mixture and squeezed in the hands to form a ball. This ball, when placed on a dry glass slab and rolled under the hand, must flow into a bar and must not crumble until it extends beyond the hands. The contents of the mixer were then transferred to a jar and covered with a damp cloth and waxed paper. The clay was then aged for three days. The same procedure was followed for the 50% ball clay plus 50% flint mixtures.

After three days' storage, the ball clay and the ball clay-flint samples were removed from the jars. A representative sample of each was obtained and molded into a ball which was weighed and dried to a constant weight and then reweighed. Thus the moisture content of the clay was determined.

Each sample was then fed into the deairing pug mill and the vacuum was established. The extruded bar was round and one inch in diameter. If the extruded bar did not emerge with uniform cross section and a smooth face, the entire mass was extruded, dampened, and again stored. If the practice of estimating the required moisture content as previously described produces too stiff a mixture, the error in the original water addition should be made the basis of modification on all subsequent clay tests.

Extruded bars were cut to 7-inch lengths, marked for identification and shrinkage, and the second, intermediate, and next-to-last bars were weighed for moisture content determination. The bars were air-dried for three days and were turned every 24 hours. After three days, they were dried to constant weight in a steam drier.

The bars were then measured and every third bar of a set was tested for dry modulus of rupture. The remainder of the bars were then stored for other tests.

The following is a table of the results for the three clays tested:

No. 2 Ball Clay 100%

Water of plasticity	
(Added to dry clay)	35.2% dry basis
(Before extrusion)	27.6% dry basis
(Extruded bars) (avg.)	27.2, 27.4, and 26.9%
Drying shrinkage (avg. of 25 bars)	4.76, 5.49, and 4.35%
Dry modulus of rupture (avg. of 7 bars)	409.4, 433, and 353 lb./sq. in.

No. 2 Ball Clay 50% and 200-Mesh Flint 50%

Water of plasticity	
(Added to dry clay)	24.6% dry basis
(Before extrusion)	18.6% dry basis
(Extruded bars) (avg.)	17.09, 17.3, and 16.88%
Drying shrinkage (avg. of 24 bars)	2.69, 3.28, and 2.13%
Dry modulus of rupture (avg. of 8 bars)	328, 396, and 322 lb./sq. in.

No. 1 Ball Clay

Water of plasticity	
(Added to dry clay)	35.0% dry basis
(Before extrusion)	29.2% dry basis
(Extruded bars) (avg.)	26.64, 27.0, and 26.06%
Drying shrinkage (avg. of 24 bars)	5.2, 5.5, and 4.8%
Dry modulus of rupture (avg. of 7 bars)	530, 577, and 495 lb./sq. in.

No. 1 Ball Clay 50% and 200-Mesh Flint 50%

Water of plasticity	
(Added to dry clay)	23.2% dry basis
(Before extrusion)	21.6% dry basis
(Extruded bars) (avg.)	20.6, 20.7, and 20.5%
Drying shrinkage (avg. of 24 bars)	5.2, 5.5, and 4.8%
Dry modulus of rupture (avg. of 8 bars)	510, 526, and 488 lb./sq. in.

No. 3 Ball Clay 100%

Water of plasticity	
(Added to dry clay)	26.6% dry basis
(Before extrusion)	22.3% dry basis
(Extruded bars) (avg.)	22.2, 22.3, and 22.1%
Drying shrinkage (avg. of 24 bars)	4.9, 5.5, and 4.8%
Dry modulus of rupture (avg. of 8 bars)	674, 716, and 628 lb./sq. in.

No. 3 Ball Clay 50% and 200-Mesh Flint 50%

Water of plasticity	
(Added to dry clay)	23.9% dry basis
(Before extrusion)	18.5% dry basis
(Extruded bars) (avg.)	17.4, 17.6, and 17.2%
Drying shrinkage (avg. of 24 bars)	2.5, 2.7, and 1.6%
Dry modulus of rupture (avg. of 7 bars)	441, 501, and 379 lb./sq. in.

It is apparent that some relationship exists between the moisture content of the extruded bars and the drying shrinkage. The loss in water during the process of extrusion under deairing conditions is also recognized. The dry modulus of rupture of the three clays tested shows a remarkable consistency, the maximum and minimum values being less than 10% from the mean. Drying shrinkages were also remarkably uniform (within about 10%).

The effect of mixing with an equal amount of flint, however, disclosed a distinctly different type of data. For No. 1 ball clay, which has a high Al_2O_3 content for a ball clay, the water of plasticity dropped from 29.2 to 20.6% although the drying shrinkage was practically the same for the pure clay and the 50–50 mixture. The dry modulus of rupture of the 50–50 mix was only slightly less than for the pure clay.

For the No. 2 ball clay the water of plasticity of the 50–50 mix was slightly less than for the pure clay and the dry modulus of rupture was only about 10% less than for the pure clay. This clay has appreciably less Al_2O_3, hence more silica, than the No. 1 clay, according to analyses furnished.

The No. 3 clay shows a distinctly less variation in water of plasticity between the pure clay and the extruded bars, and the difference between the drying shrinkage of the pure clay and the 50–50 mix is greater. There is also a difference in the dry strength of the pure clay and the 50–50 mix. The pure clay shows an abnormal dry modulus of rupture, but the 50–50 mix is approximately the same as the No. 2 ball clay. This clay, according to its chemical analysis, contains less Al_2O_3 than the No. 2 ball clay, which in turn contains less Al_2O_3 than the No. 1 ball clay.

A study of these values leads to the opinion that the properties of a ball clay may be definitely associated with its Al_2O_3 content, which in turn means its content of free SiO_2. This approach is planned for our next research. The optimum flint content for maximum modulus of rupture will be studied, taking into consideration the free SiO_2 content in the clay as marketed. The particle size of the free SiO_2 in the natural clay will also be studied. From this we hope to disclose a correlation which will indicate the relative strengths of the clays without injuring them by deflocculation, as would be necessary if the free SiO_2 were removed.

Chemical Analyses of Clays Tested

Ball clay	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaMgO	KNaO	Ignition loss
No. 2	54.8	29.5	0.85	1.23	0.24	2.17	11.1
No. 1	51.7	31.2	1.17	1.72	0.70	0.94	12.1
No. 3	58.8	22.2	2.45	0.78	0.45	1.83	9.9

VII. Tentative Standards

Dr. Russell pointed out that to facilitate the development of this project and to provide a basis for any preliminary testing it would be expedient to have tentative stand-

ard procedures insofar as practically possible. These tentative standards would apply to the selection and procurement of standard test materials, to the processing of these materials into test specimens, and to the handling and testing of the specimens as well as the unprocessed raw materials. Various members of the Ball Clay Advisory Committee were therefore requested to prepare tentative standards based on the best knowledge and experience available. The point was emphasized that these tentative specifications were only preliminary in nature and should not be construed as unequivocal or final. Actually, with very few exceptions, they will undergo much alteration as their discussion shows such to be desirable. It is hoped that ensuing discussion will bring out the good and poor features and show where additional study or actual research is required to clarify the points of contention or uncertainty. Any tentative standard specification is subject to change as often and as many times as is necessary to insure the evolution of a final standard which is universally acceptable and usable. Even final standards may be revised as they are shown to be deficient in any way. With this interpretation, the following tentative standards are proposed for discussion and constructive criticism. At the suggestion of *R. F. Geller* and due to the shortage of time, the tentative standards were not presented at the symposium herein reported, but were referred for publication.

(*a*) *Mine vs. Plant Selection of Ball Clay for Analysis Procedures*—J. R. BEAM

A year ago, the proposed or tentative procedure for taking samples of ball clay was based on obtaining a sample to be used as a representative sample of that clay and the analysis data used in an effort to classify ball clays.

The fallacy of classification of ball clays has been amply discussed in this symposium.

The problem now resolves itself around how to select a sample to show up the physical and chemical characteristics to the best interest of the person making the test.

A ball clay producer wants the assurance that he has good clay before spending considerable time and money moving overburden. He resorts to core drilling and opening small pits. After he has the pit open, he must know how far to mine in a given lens or seam. To make these determinations, he obviously does not want to mix his samples before testing.

During the mining operation, every effort is made to mix the clay to bring about the greatest uniformity possible.

Specifically, the analysis made on clay going into the storage shed is made to keep bad clay out of the shed. The analysis made on the clay going out of the storage checks the uniformity. These checks are largely visual observations based on previously made physical analysis.

The mixing is greatly promoted in the shredding operation and again in the unloading of the clay at the plant.

The user is interested in finding out the quality of clay he has purchased and, inasmuch as the clay is received at plants in carload units, it is natural that the sampling is also made in car units.

With this background, the actual testing procedure and sampling obviously must be designed to bring out the physical properties desired. Checking for batch-to-batch uniformity is one problem. Hunting for some particular discrepancy is another procedure.

In the batch-to-batch analysis procedure, 10-pound samples selected from various locations of a car or bin of the shredded clay, taken at least one foot below the surface, give a uniform sample. This large sample should then be reduced to the required quantity by accepted quartering methods.

(*b*) *Physical Form of Clay Samples: Lump vs. Air-Floated vs. Disintegrated (Shredded) Samples*—L. E. THIESS

Ball clay is supplied in lump, shredded (disintegrated), and air-floated form. The lump form is the least desirable because of nonuniformity. The air-floated ball clay must undergo heating and drying before grinding and air-floating and the physical properties may be altered thereby. The shredded clay, containing about 15 to 20% moisture, is the most uniform and, therefore, the shredded (disintegrated) ball clay sample should be adopted as standard.

(*c*) *Wet Clay vs. Dry Clay; Drying Procedures; Storage and Distribution of Samples*—R. E. GOULD

Ball clays, in general, are found only a comparatively few feet from the surface. Also, in many instances, the deposits are in low-lying ground where the surface moisture does not run off readily. For these reasons, ball clays, as mined, are apt to contain up to 25 or 35% of ground water, depending on the time of year.

Of late years, the user has objected to the shipment of clay with a high moisture content, and it has become an almost universal practice for the miner to dry out his clay, at least partially. This practice also permits (1) storage throughout those periods of the year when mining is difficult and (2) the drawing of a more uniform product from stock piles which cover a fairly extensive mining operation.

The effect on a ball clay of a high moisture content may be secondary to the effect of the process of removal of the excess moisture, preparatory to sampling. This statement, of course, cannot be accepted too literally, but it may be assumed that little clay is used by ceramic men when the shipment took place directly after the mining operation. In testing procedure, therefore, some standard method should be used to dry the sample preparatory to running tests on it and for the storage of "standard samples" to be held at the plant for reference.

As most testing is done on a dry weight basis with an added mixture of 50% of standard flint, it is recommended that the ball clay be tested with the moisture "as received" and that average samples for moisture determination be dried out in the usual accepted manner. After calculation of the water content, however, the clay should be blunged with the natural moisture in it and the dried sample should be discarded. Clay should also be stored with due regard to the impeding or slowing down of further drying, and samples should be kept in bags lined with paper or other material to prevent the passage of air over and through the clay.

Little has been done to correlate the effect on such vital properties as plasticity, dry modulus of rupture, shrinkage, and firing behaviors between ball clays which were received in a very moist condition and those which were received after a slow air-drying treatment. It is suggested, therefore, that data be kept and submitted for comparison on this feature, as it is entirely within the bounds of reason that the moisture content of clays has a greater effect on the physical properties than is now suspected. More emphasis may be placed on the procurement of clay which is "dry" than is justified by the saving in freight.

(*d*) *Clay vs. Clay-Flint vs. Standard Body Mixtures*—A. J. HEDQUIST

The consensus of opinion at the 1943 symposium favors a 50–50 mixture with a standard grind of flint. With this the writer agrees, as approximately 50% of nonplastic, preferably flint, is required to dry and form most ball clays so that comparable results can be obtained for transverse dry strength.

Hewitt Wilson, in his open letter published in the January, 1944, *Bulletin*, pp. 25–28, contends that 50% flint is often insufficient to obtain proper drying and that the 60% flint gives more uniform and consistent results. This should be a good point to consider in a new set of standards.

One hundred per cent clay and standard body compositions were ruled out as follows: 100% clay in most cases is too difficult to dry and form but is necessary for determining such factors as fired color, grain size, and organic and soluble salt contents.

Standard body mixtures are too limited in their application or, if on a body basis, require a study which involves many types of bodies.

(*e*) *Choice of Standard Materials, Water Selection, and Compensation for Moisture in Materials*—HARRY THIEMECKE

The matter of determining the various physical properties of a ball clay on the clay alone, combined with flint in a 1 to 1 ratio or on a standard body combining the ball clay with flint, feldspar, and kaolins, is a moot question. To date there has been no agreement on this among the Committee members. Each type of test has certain distinct features which may be advantageously used for determining certain physical properties of the ball clay in question. Also, each type of test possesses limitations. Heretofore, testing of the ball clay alone or in admixture with flint has received most favor and represents the method most extensively used in the past. By including tests on a ball clay-feldspar-flint-kaolin body, the picture becomes complicated by the introduction of additional variable materials which in themselves require standardization. As a result, the question arises whether the results obtained on a body of this type compared with those obtained on one comprising only ball clay and flint warrant such complications.

Should the Committee include the complete body test in its standard procedure, the selection of a typical flint, feldspar, and kaolin must be made. As these materials are made available from various locations by various producers, possibly the selection of a typical flint, feldspar, and kaolin should be left to lottery practice to obviate giving offense to any of the producers and eliminate undue sales publicity for any others.

The chemical compositions of the selected flint and feldspar should be established in the usual analytical manner. A mineralogical determination of the selected feldspar should also be made. Fusion behavior of the feldspar alone or in admixture with the selected flint would be advisable. As feldspar is slightly soluble and shows surface activity, the importance of standardization in regard to particle-size distribution is obvious. Mechanical strength is also influenced by the grain-size distribution of both the flint and feldspar. The usual pottery grind of feldspar and flint results in a predominance of subsieve particles and for standardization, in addition to the wet-screen analysis, would involve one of such sedimentation methods as (*a*) elutriation, (*b*) Casagrande hydrometer, (*c*) Wagner turbidimeter, (*d*) Andreasen pipette, and others. To eliminate subsieve determinations, the suggestion has been made to use a feldspar and flint which have been graded between two screen sizes such as, for example, 150–200 mesh. This practice may have merit and would certainly simplify one phase of the standardization.

In the selection of a kaolin for the standard body test, such factors as (*a*) species (primary or secondary), (*b*) grain size, (*c*) grain shape, (*d*) type (hard or soft as particularly applies to the Georgia kaolins), (*e*) soluble-salt content, (*f*) mineralogical composition, etc., would have to be given utmost consideration. A limit should be observed, however, on the standardization made on the kaolin as, in the extreme, it is conceivable that the standardization tests for the kaolin might become as involved as that for a ball clay.

In view of the variations in the physical properties that occur from one batch of separately prepared raw material from the next, should a standard test body incorporating kaolin, feldspar, and flint be agreed upon by the Committee, to eliminate checking of these materials separately by the various ball clay investigators concerned, it is certainly advisable to acquire a large quantity of these materials, test them under standardized procedure, store in a manner and place recommended by the Committee, and distribute as required.

As water from various sources contains varying amounts and types of soluble salts which would influence the results obtained in some of the tests made on the ball clays, it is recommended that the water used in all tests be distilled. An alternative, of course, is rain water.

Should the raw materials be stored in large quantities and distributed as needed, the moisture content, if present at initial storage, would approach a minimum constant. The flint and feldspar would be practically dry as received, and any moisture present in the kaolin should be compensated for by the ball clay investigator at the time of incorporating the kaolin in the standard test body.

(*f*) *Batch Preparation*—EDWARD SCHRAMM

Disintegrate the sample to small lumps. Soak 16 hours in water at room temperature using 2 parts water to 1 part clay. Blunge 2 hours and screen through 100-mesh. Dewater the slip on plaster bats and bring to the desired working condition. Thoroughly wash the residue on the screen (but do not add wash water to the slip). Dry the residue and weigh to determine the lignite content.

(*g*) *Forming of Test Specimens*—J. W. WHITTEMORE

(1) The prepared batch shall be shaped into a compact mass that will feed rapidly into the extrusion equipment.

(2) The apparatus to be used in forming shall be such that the following conditions may be obtained: (*a*) The clay shall be shredded to pass into the auger chamber. The shreds shall not be greater than $^3/_{32}$ inch in any dimension of cross section. (*b*) The shreds shall have no chance of massing until after they have been exposed to the vacuum condition. This would be obtained most easily by having the shreds fall through a space in an evacuated chamber. (*c*) The evacuation chamber of the apparatus shall be maintained at a vacuum pressure of not less than 20 inches of mercury. (*d*) The impelling force for shredding and for extrusion may be obtained from pistons or augers. In either case, the piston or auger shall fit with the liner of the chamber to maintain a constant pressure across the face of the die. (*e*) The diameter of the piston or the auger shall be greater than one and one-half times the greatest dimension of the die. (*f*) The depth of the die shall be 0.500 ± 0.125 inch.

(3) All of the batch shall be passed through the extrusion apparatus once and then refed through the apparatus before any test specimens are obtained.

Comments

(1) It is presumed that all matters relative to composition, tempering, and preparation have been decided. The batch should be shaped into a compact mass to prevent excessive evaporation before introduction into the extrusion apparatus.

(2) No particular piece of equipment is named, as agreement on requisites for such an apparatus may encourage a superior piece of apparatus to any on the market at the present time. (*a*) The batch should be finely divided to insure complete deairing. (*b*) If the shreds are allowed to mass together before exposure to high vacuum there would be a possibility of unequal deairing. (*c*) If the regulation is not included, some laboratories might be lax on control of the degree of vacuum. It would also insure some method for measuring the pressure within the vacuum chamber. (*d*) For standardization, either the piston or the auger method should be specified so that the work in different laboratories may be compared. (*e*) This regulation will assist in insuring an equal pressure over the entire section of the issuing column of clay.

(3) The purpose of this paragraph is to insure the same degree of deairing in all test specimens. The first material passing through the machine might not be thoroughly deaired.

No reference is made to hand-wedging, as in both of these cases the human element would prevent fair comparisons of work at different laboratories.

(*h*) *Standardization of Moisture Content for Molding; Method of Determination*—SIDNEY SPEIL

It may be impossible to secure a mechanical method satisfactory for all clays. Any method of standardizing moisture content for molding should give not only reproducible results but the optimum moisture content for each clay. The properties of any clay, e.g., modulus of rupture, determined on bars made with this water content should be the maximum possible for that clay if different clays are to be compared.

There are two possible methods of approach: (1) direct

determination of the point of optimum workability and (2) determination of workability limits and interpolation to obtain the mean moisture content of this range. The use of the A.S.T.M. soil plastic limit machine (modification of the Atterberg test) is a simple approach to the problem. Whether this apparatus can be adopted for our purposes can be decided only by the experimental results obtained with the tester. A simple compression test such as that described by McDowell and Vachuska[6] might be tried as well as the other extrusion and penetration tests suggested at the last symposium. It may be more satisfactory to determine the working limits with the extrusion apparatus used in forming the specimen, as discussed by Hewitt Wilson (January, 1944, *Bulletin*, pp. 25–28). In any case, an experimental program would be required to correlate the effects of variations in moisture content with the data obtainable by modifications of the A.S.T.M. plastic limit test or by any other test.

The simplest physical property to measure would be modulus of rupture, dry and fired. One starting point might be the determination of the variation of strength with moisture content over the central portion of the moisture range suitable for an extrusion machine, and determination of the position of the optimum moisture with respect to the extreme moisture contents usable with the machine. A sample of each moisture content could be tested in a simple compression test, in the A.S.T.M. soil plastic limit test, and by the empirical "feel" test. A sticky-point test and a liquid test should also be made in this preliminary survey and the position of the optimum with respect to these limits determined. After a sufficient number of dissimilar clays had been tested, it should be possible to determine whether any correlation exists between the moisture content for maximum modulus of rupture and any of the other data which have been obtained.

Until some experimental data are available, no tentative method for standardization of moisture content can be justified as being definitely superior in all cases to the present empirical plastic feel method.

(*i*) *Specimen Drying Procedure: Storage of Specimens*—V. J. ROEHM

The Committee last year reported the following tentative standard for the drying procedure and storage of specimens:

After air-drying for 48 hours, the specimens shall be placed in a drier at 100°C. for 60 hours. All specimens for the determination of dried properties shall be transferred directly to a desiccator and stored there until immediately before testing to avoid serious differences due to moisture absorption from the atmosphere. No specimen shall be tested until it has cooled to room temperature, but the period of subsequent storage is not critical for the determination of dried or fired properties. The specimens to be used for fired determinations may be stored in any normal room atmosphere upon removal from the drier, and any extreme dampness shall be avoided.

Mr. Meeker has suggested alternately turning the specimens every 4 hours during the preliminary drying until they are safely past the warping and cracking stage and covering the specimens overnight when turning cannot be accomplished.

Such a procedure, however, might produce a strain in the specimen which would show up in the transverse green strength.

Of course, warping and cracking are associated with the rate of drying. There possibly should be a limit as to how close one bar should be to another in the initial drying. Should a screen of clay be placed so that the ends of the bars do not dry faster than the middle section?

Would warping and cracking be cut down if perforated boards were used and these in turn were placed on a support so that there was an air space on the underside of the specimens?

Mr. Geller prefers to place specimens in a cold oven, then bring the oven gradually to a temperature of 110°C. This point seems to be well taken. Putting specimens, however, in a hot oven after 48 hours of air-drying should not cause difficulty.

(*j*) *Rate of Drying; Drying Characteristics (Cracking, Warping, Discoloration); Drying Shrinkage; Dry Transverse Strength*—A. S. WATTS

The test pieces, as soon as formed and marked for identification and shrinkage measurement, are transferred to a desiccator, a stoneware jar, or another container which is airtight and in which the air is maintained at 80 to 90% relative humidity. Here they remain for at least 24 hours and are then removed to room atmosphere and placed on drying pallets constructed of open wood frames 10 inches wide by any desired length with wires across the 10-inch face at $1^1/_2$-inch intervals and over all a tightly stretched cambric cloth attached only at the ends of the pallets. The trials, spaced between the wire supports, are measured for shrinkage at 2-hour intervals until air shrinkage is complete. They are then transferred to a heated drier operated at not more than 120°F. and measured at 1-hour intervals until no further shrinkage is indicated. At each reading of shrinkage the trials are inspected for cracking, warping, and discoloration, and a record is made of the amount and character of same.

If so desired, tests may be conducted under controlled temperature and humidity conditions to determine (1) shrinkage vs. drying time, (2) weight loss vs. drying time, and (3) shrinkage vs. weight loss.

Dry transverse strength measurements should be made on a 5-inch span supported on round rods $^1/_4$ inch in diameter, and the load should be applied on a rod $^1/_4$ inch in diameter, the contact face of which is reduced to a $^1/_{16}$-inch radius. The rate of load application should be uniform at 10 lb. per minute. The modulus of rupture is determined by the formula

Square bars:	*Round bars:*
$M = \frac{3Pl}{2bd^2}$	$M = \frac{8Pl}{\pi d^3}$

M = modulus of rupture (lb. per sq. in.).
P = breaking load (lb.).
l = distance between supporting rods (in.).
b = breadth of bar (in.)
d = depth or diameter of bar (in.).

Calculation of load applied must be on the basis of method of application, i.e., direct or by the use of a lever.

(*k*) *Soluble Salt Determination in Clays*—K. C. MCCARTT

(1) SAMPLING

In sampling a car of clay, samples should be taken from four or five points on the working face of the clay as the car is being unloaded in such a manner as to obtain a cross section of the face from top to bottom. The samples totaling approximately 15 pounds should be mixed and used for subsequent tests. After making a moisture determination, weigh out an amount of clay equivalent to 10 pounds dry weight and add distilled water to make a total of 35 pounds. Mix 5 hours by turning end-over-end in a 5-gallon churn at 35 r.p.m. The final specific gravity of the slip should be approximately 1.21. Reserve a portion of the slip for pH and acidity measurements. Filter the water from the slip by using a small filter press which has been washed with distilled water or by any other convenient method which will not contaminate the filtrate. Reserve the filtrate for sulfate, chloride, and soap-hardness analyses.

(2) TERMS USED IN REPORTING DATA

Results should be expressed as e.p.m., i.e., gram equivalents per million grams of dry clay substance.

(3) CHLORIDE ANALYSIS[7]

To 50 ml. of the filtrate obtained by the procedure in

[6] S. J. McDowell and E. J. Vachuska, "Effect of Calcined Cyanite in Porcelain Bodies," *Jour. Amer. Ceram. Soc.*, **10** [1] 64–72 (1927); p. 67.

[7] W. W. Scott, Standard Methods of Chemical Analysis, 2th ed. D. Van Nostrand Co., Inc., New York, 1939; p. 5054.

paragraph (1) add one ml. of 5% potassium chromate indicator solution and titrate with $N/60$ silver nitrate solution. After correcting for the blank obtained with distilled water, multiply the corrected ml. of silver nitrate solution by 0.83 to obtain the chloride concentration in e.p.m. (paragraph (2)).

(4) SULFATE ANALYSIS[8]

Pipet 25 ml. of the filtrate obtained in (1) into a 300-ml. Erlenmeyer flask and, if necessary, adjust the pH to a value between 4.5 and 8.5 with $N/100$ hydrochloric acid or $N/100$ sodium carbonate solution. Then add 25 ml. of sulfate-free isopropyl alcohol and mix by shaking. Add 0.2 grams of prepared tetrahydroxyquinone indicator and mix thoroughly by shaking. Titrate to a rose color with constant shaking using a white (not daylight) lamp for illumination. The ordinary incandescent lamp or the "3500° white" fluorescent lamp is suitable. Use 0.0125 molar barium chloride solution for the titration. If more than 10 ml. of the barium chloride solution are required, dilute the sample quantitatively and repeat the process. The addition of 2 to 3 ml. of $N/60$ silver nitrate solution or its equivalent will increase the sharpness of the end point. After subtracting the blank, multiply the corrected ml. of barium chloride solution by 2.5 (for 25-ml. sample) to obtain the concentration of sulfate in e.p.m. (paragraph (2)).

(5) SOAP HARDNESS

Pipet 50 ml. of the filtrate from (1) into a soap test bottle and adjust to a pH of 8.5 (faint pink of phenolphthalein) with $N/100$ sodium carbonate solution. Titrate with Hagan standard soap solution (1 ml. = 0.342 e.p.m. $CaCO_3$ for 50-ml. sample) by shaking vigorously after each addition of soap solution until a lather is formed which will not break for at least 2 minutes. After subtracting the blank, multiply the corrected ml. of soap solution by 0.855 to obtain the concentration of calcium plus magnesium in e.p.m. (paragraph (2)). If more than 8 ml. of the soap solution are required, dilute the sample quantitatively.

[8] R. T. Sheen and H. L. Kahler, "Direct Titration of Sulfates; Further Studies with Tetrahydroxyquinone as Internal Indicator," *Ind. Eng. Chem., Anal. Ed.*, **8** [2] 127–30 (1936); *Ceram. Abs.*, **15** [8] 258 (1936).

(6) pH

Measure the pH of the slip sample from (1) with a glass-electrode pH electrometer.

(7) ACIDITY ANALYSIS[9]

Weigh out 17.5 grams of the slip from (1) to the nearest 0.1 gram in a 250-ml. beaker. Cool to approximately 5°C.; at the same time cool the reagents used and some carbon-dioxide free distilled water. When ready to make the analysis, add 10 ml. of 10% sodium chloride solution and enough of the distilled water to make the total volume 50 ml. The titration and pH measurements given below should be made using a glass-electrode pH electrometer equipped with external electrodes and a mechanical stirrer (electrometric titration setup). After the sample has been diluted to 50 ml., insert the electrodes and the stirrer into the mixture. Then, using continuous agitation, add enough chilled $N/100$ sodium carbonate solution to bring the pH to 8.5 or higher. Back-titrate with $N/100$ hydrochloric acid solution to a pH of 8.5 and then a pH of 4.5, allowing sufficient time for constant readings as each end point is approached. Record the ml. of sodium carbonate added and the ml. of hydrochloric acid at each end point. Then repeat the test using the same volumes of sodium chloride solution, sodium carbonate solution, and distilled water in a blank run. The amount of hydrochloric acid used at 8.5 pH should be one-half the amount of sodium carbonate solution used and at 4.5 pH should equal the amount used. If not, a correction should be made on the amounts used in the original titration.

Calculation of results: After correcting for the results obtained in the blank run let

N = ml. of sodium carbonate solution used.
P = ml. of hydrochloric acid solution used at 8.5 pH.
M = ml. of hydrochloric acid solution used at 4.5 pH.

Then:

When M is greater than N

Weak acid (e.p.m.) = $N - 2P$
Weak base (e.p.m.) = $2(M - N)$

When M is less than N

Strong acid (e.p.m.) = $2(N - M)$
Weak acid (e.p.m.) = $2M - 2P - N$

The above results are as stated in paragraph (2).

[9] W. W. Scott, *op. cit.*, p. 2267.

Collective Research

Published above under the title "Ball Clay Investigation" is the record of Symposium III conducted at the Forty-Sixth Annual Meeting of The American Ceramic Society in Pittsburgh, Pa., April, 1944. This report has been reviewed and edited by several members of the Committee and completely edited by the Chairman. It contains not only plans, with Committee structure for this investigation, but many of the procedures and standards to be used. Finally, it contains some of the preliminary work.

The clayworking industry will be under great pressure from competitive products when the war is over. This pressure will come, not only from other ceramic products, but from organic materials and metals. There is only one way to meet this encroachment, that is, research.

Individual research is good, but collective research covering many sections of the country and many plants, and joined in by many competent men, will be better. The best minds of the industry must meet these problems.

The Ball Clay Investigation is an ideal example of collective research. We extend congratulations to the members of the Committee and commend their work to your attention.

The Editor

AMERICAN CERAMIC SOCIETY

Forty-Seventh Year

Edwin Henry Fritz

THE PRESIDENT'S ADDRESS*

By Edwin H. Fritz, *President, The American Ceramic Society*

Another year of war has passed since our last Annual Meeting. Our military forces have made great progress. The victorious end of the European War is now definitely in sight, and the Pacific War begins to show signs that victory is not too far away, but for the first time the war has seriously affected Society affairs and activities. At the Government's request, because of the heavy demand on our transportation and hotel facilities, we have cancelled the technical sessions of our Forty-Seventh Annual Meeting and have asked our members to forego their usual personal attendance. The Board of Trustees, officers of Divisions and Classes, and Committee chairmen will hold executive sessions on April 16 and 17. The April 16 meeting of the Upstate New York Section will provide the occasion for the necessary business consisting of reports of the Secretary and Treasurer, installation of officers, induction of newly elected Fellows, and the Edward Orton, Jr., Fellow Lecture by Clarence S. Ross.

The cancellation of the Annual Technical Program Meeting is a more serious problem for The Society than one contemplates at first thought. The Meeting provides not only contact between the members and the resulting interchange of information upon which the strength of The Society largely rests, but also furnishes the bulk of the material for our publications during the ensuing year. Obviously, we cannot afford to let our publications become less valuable because of lack of material, as they are the heart of The Society's activities and accomplishments.

* Presented at the Executive Meeting of The American Ceramic Society, Inc., Buffalo, N. Y., April 16, 1945. Received March 13, 1945.

Happily, positive steps were immediately taken to maintain the flow of publication material by direct contact with the authors of papers that had been scheduled for the Meeting and by appeals particularly to the Local Sections, who can effectively fill the gap by holding meetings this spring and subsequently, making them more elaborate by inviting the presentation of papers that otherwise would have been presented at the Annual Meeting. Our Local Sections have a great responsibility which they have accepted gladly and with enthusiasm.

The Society Has Grown

The past year has been a very satisfactory year for The Society. Individual and corporation memberships have substantially increased to levels higher than ever before, largely owing to the continuous efforts of the Membership Committee through the medium of its "Double the Membership" campaign. Although the accomplishment of the campaign slogan was expected to require several years, it is definitely possible and the campaign should by all means be continued. The field of potential membership remains large, particularly among operating men, and with greater cooperation by all of our members the goal can unquestionably be reached. An increase of 13.1% in membership since a year ago indicates what has already been accomplished.

Financially, The Society had an excellent year. Income was well above expenses and consequently more than $10,000 was added to our surplus and reserve funds. The larger membership, an increase of 12% in advertising income, and careful control of expenses made this possible. If these results are continued for a few more years (which can be done), our invested reserve will become large enough to make additional activities possible. This prospect certainly should be gratifying to all of us and stimulate our interest in The Society.

Student Branches and Local Sections

Our Student Branch activities naturally continue at a low ebb, but this is no cause for concern, as our educators expect to have all of these organizations going and active as soon as the war is over and the influx of students begins. The condition of our Local Sections is excellent, except for a few areas. In spite of gasoline rations, practically all of them have had at least two meetings since last autumn, with attendances running as high as 125. Furthermore, two new Sections have been organized, the Northern Ohio Section and the Northwestern Ohio Section. Both of these Sections made excellent beginnings and already indicate that they will be among our strongest Sections. Prospects are good for the early organization of additional new Sections in one or two areas. The Secretary made definite plans to visit the Pacific Coast Sections during the year but was unable to obtain transportation accommodations. This will be done, however, at the earliest opportunity, this spring if at all possible, because a very important part of our membership is represented by these Sections.

My visits to many of the Sections during the year have impressed upon me their importance to The Society. They have a remarkable opportunity for interesting men and women in the work of The Society who otherwise would not be reached and to provide contacts among those of ceramic interest who have no other such opportunity. This is particularly true of our younger members who often are unable to attend Society Meetings. All of us should, therefore, take an interest in our Local Sections and attend and take an active part in the meetings of the nearest Section. The work of organizing new Sections should be continued. In areas where the potential membership seems insufficient, the organization of clubs might well be considered. This idea will be tried this spring in connection with the plan to have as many local meetings as possible in lieu of the Annual Meeting.

Local Section Finances

The question of financial support for the Local Sections is becoming more important. Many of the Sections are hampered in their efforts to arrange good programs because of insufficient funds, and some have appealed to The Society for assistance. A modest beginning was made during the year to provide such help by making available a limited amount of money where, in the judgment of the President, it would definitely promote the activity and strength of any Section. A few of the Sections have taken advantage of this. I feel, however, that The Society should very soon consider a definite program of financial support for all of our Sections. This might well be the rebate to the respective Local Sections of a small portion of the dues of those Society members who are Local Section members. I am convinced that this will, before long, pay big dividends in larger Society membership and, what is more important, in more interested and active members.

Ceramic Society Building

A Building Committee was appointed early in the year to study the housing of our Columbus headquarters and to determine whether a new building should be provided or whether a move to larger quarters should be made. This committee properly concluded that no immediate action was necessary, as it was possible during the year to enlarge our present quarters. The committee expects, however, to develop some preliminary plans for a new building so that this idea can be more intelligently discussed whenever the need becomes more apparent.

Research Endowment Fund

More recently, as a result of increasing interest in the idea, a committee was appointed to study the advisability of establishing a research endowment fund and, in general, plans for enlarged activities. Although the committee is reporting at the April meeting, the subject is so important that I particularly wish to discuss it here. The various things I have reviewed so far which mean progress for The Society will mean nothing and actually cannot be accomplished unless The Society broadens the scope of its work and increases its service to the ceramic industry. The Society has done well in this respect up to the present time. Its record shows remarkable growth and increased activities in many directions, particularly in the last twenty-five years. We cannot afford to rest on our laurels, however, and become static; we must continue to go forward. Our services can be enlarged in numerous ways. We need to do more in determining the fundamental research needs of the industry and in promoting work on these subjects in the various institutes, bureaus, experiment stations, and

universities. We need to do a better job in encouraging the writing of papers and the building of programs for technical meetings. We need to do more in the promotion of meetings and discussions on subjects and problems of vital interest to various divisions of the industry. We need to develop and establish more ceramic product specifications, standards, and tests. We should increase our abstracts; we need particularly to make available translations of important foreign language papers. We should provide some form of employment service for the benefit of ceramists in the armed forces when they are discharged from service. Salary studies should be made in connection with this. We need more papers and other data and information in our publications of direct interest to the practical operating man. A question-and-answer section on practical problems or instructional courses on various phases of ceramic manufacture have been proposed. We should provide information on the various phases of management, such as labor relations, cost control, and employee and supervisory training. The gathering and publication of factual data on these subjects alone would be a great service and fill an important need.

These are the more important needs at the moment. Many others could be named. Taking care of such needs, however, would require much more work than is now being done by The Society. How can this be accomplished? It is hardly possible with the present organization which depends on committees working with the officers of The Society and the Divisions. All of these men, with the exception of the Secretary, have their own jobs and responsibilities, and their Society work necessarily can take only a relatively small portion of their time. Considering the excellent work that has been done and the accomplishments through the years, we cannot expect more from this arrangement. It will require an expanded organization to increase our services and do the things which I have mentioned.

During the past year, the Illuminating Engineering Society has added a full-time Technical Secretary to its staff, who, at present, is devoting his time primarily to the writing of a handbook but who, before long, will concentrate on consulting with and securing reference material and exchanging progress data between the technical committees of their Society. He will also serve in a liaison capacity between their Society and the technical agencies and organizations whose work is of interest to their Society. The cost of this Secretary and incidental expenses which are being paid out of general Society funds is approximately $10,000 per year.

The Illuminating Engineering Society has also established a research fund which has been accumulated over the years and at present consists of approximately $40,000. Contributions by individuals and companies are constantly being urged by a special committee and they hope to build up the fund so that it will always aggregate between $50,000 and $100,000. The purpose of the fund is to stimulate research in their field by educational institutions, testing laboratories, and other competent organizations. The fund can also be used to make possible the securing and ownership of patents resulting from the contemplated research work, such patents to be made available to the industry on whatever basis is considered proper. The administration of the fund is in the hands of a Board of Trustees, consisting of seven members, which has the power to receive and allocate moneys for the purposes indicated and to appoint a Research Executive Committee which examines all proposals for research and advises the Trustees concerning them. To date, no funds have been allocated to any research projects, but the Trustees hope to expend the principal rather than depend upon income from the fund, probably as soon as the total has reached a satisfactory level and sufficient new contributions are in sight to maintain it.

Such a setup could very well provide the necessary facilities and additional organization to accomplish the new and increased services which I have outlined for our Society. A Technical Secretary would fit into this program and, assuming that he would have a broad knowledge of ceramic science and technology, he would be able to direct or carry on many of these activities himself. The present Secretary would then become an Executive Secretary who could devote his time more to the business and administrative phases of The Society which are also important but require a man of different caliber and ability. Such a combination would be ideal to make possible an enlarged program of activities, particularly after Dr. Purdy retires from active service in 1946. The cost of a Technical Secretary can be expected to run close to the Illuminating Engineering Society figure of $10,000 per year. Although this is a sizable addition to our budget, it can easily be handled with increased income from a continuation of the work to increase our membership and advertising. The addition of a Technical Secretary will in itself encourage membership in The Society because of the increased services that will be offered and thus there should be no doubt about our ability to increase our income from this source. As we increase our membership, moreover, advertising in our publications becomes more valuable and desirable. The entire program, therefore, is closely related and its accomplishment can be made simultaneous.

A research fund is another important item in the program for enlarged services. To place it on an endowment basis is undoubtedly a difficult task because of the low return and the consequent very large principal that would be required to provide funds of any consequence. The Illuminating Engineering Society plan of expending the principal and constantly replenishing it by contributions has much merit. The setting up of the fund then becomes much easier, and, although contributions would have to be solicited each year, I am confident that these would be forthcoming if the fund were wisely and effectively administered. A research fund would make possible important fundamental research and data and, although it is true that probably no single project would be of interest to the entire ceramic industry as represented by our membership, it should be possible to allocate funds to diversified projects so that each contributor would receive something of direct value.

It is my conviction, therefore, that a research fund is definitely needed by The Society to carry on and accomplish the enlarged program which it should undertake. I have already mentioned that our invested reserve, if the present trend is continued, may soon reach a size to make

additional activities possible. I am not advocating that our present reserve be converted into a research fund because, obviously, we must have a substantial reserve to carry us over lean years that may be ahead. The present total, however, is adequate for that, and we could, therefore, begin now to place our surplus each year into a research fund, but only as long as the reserve for operating expenses is at or above a safe minimum. This, augmented by organized solicitation for contributions, should make a research fund of sufficient size to start allocations an early possibility.

The Society's Place in Postwar Prosperity

The postwar period which is not far ahead will bring with it new competition for ceramic products from the nonceramic field. On the other hand, some of our ceramic products will enter new markets and compete successfully with other types of products. To meet the problem of new competition and to take full advantage of the opportunity for new outlets, the ceramic industry needs the help of a technical society which has a clear understanding of these problems and the organization and facilities to provide every possible assistance in solving them. This situation in itself demands, therefore, that we take action on a program of enlarging our activities and services such as I have outlined.

The recommendations which I have made in this address are based upon my experiences and observations during the many years that I have been active in the ceramic industry and a member of The Society and, particularly, upon the experiences and observations during the past year while I was privileged to serve as your President. It is my sincere conviction that they are necessary if The Society is to meet its responsibilities and fulfill the purposes for which it was founded in the years that lie immediately ahead. To lay them clearly before you, I will summarize them in the following six-point program.

(1) Continue the campaign to "Double the Membership" until the goal is reached.

(2) Continue the efforts to increase the advertising space in *The Bulletin*.

(3) Organize new Local Sections in all areas where there is sufficient Society membership or ceramic interest. Try the idea of organizing ceramic clubs in some localities where the potential membership is not sufficient for a Local Section.

(4) Provide financial assistance to the Local Sections in some definite form, such as a rebate of a portion of the dues of Society members.

(5) Add a Technical Secretary to The Society staff as soon as possible after the retirement of Secretary Purdy from active service.

(6) Establish a research fund and build it up to $75,000 by the time of the fiftieth anniversary of The Society three years hence. Allocations from this fund could then be started for fundamental research projects or the development of important statistics or data, after the necessary details of administration have been worked out and established. Contributions to the fund are to be obtained from organized solicitation from the industry and by diverting to it any surplus of Society funds from operating results, provided the reserve for operating expenses is at or above a safe minimum as determined by the Board of Trustees.

It has been a pleasure to serve you during the past year to the limited extent of my time and ability. If I have accomplished anything, it has only been because of the splendid cooperation and assistance of those I have called upon, and to all of these I wish to express my sincere thanks. The fine spirit and willingness to serve of these men speaks well for the future of The Society. Finally and most importantly, I wish to pay tribute to Ross Purdy and his staff at The Society offices for their complete and invaluable cooperation and the excellent manner in which they have handled Society affairs.

STUPAKOFF CERAMIC & MANUFACTURING COMPANY
LATROBE, PENNSYLVANIA

POSTWAR EMPLOYMENT*

BY F. D. NEWBURY

No issue has been more widely discussed than the question of full employment after the war. Discussion has ranged widely over such aspects of the problem as the probable size of the postwar labor force, the definition of "full employment," the conditions necessary for maximum employment under private capitalism, the right of every willing worker to a job, and the respective parts that private industry and Government should play in postwar employment. In the present brief paper, only the first of these questions will be discussed—the size of the postwar labor force and the number of civilian jobs that corresponds to a satisfactory level of civilian employment.

It is obvious that "full employment" in the literal sense is not intended; employment and work are not the real objectives; these are only the means to the desired goals of better living and better health. What we all really desire is to continue progress in the American tradition of more goods for less work. Social gain lies in this direction and not in the unqualified increase in the number of jobs. No one, for example, wishes to turn the clock backward to the hard labor and long hours of the earlier years of the nation, and certainly no one wishes to change the trend toward a shorter span of the average man's working years. Dr. Victor Heiser, in his book, American Doctor's Odyssey, reports a conversation he had with his Imperial Majesty Haile Selassi I of Abyssinia in 1933, when mass unemployment in the United States was at its worst. Haile Selassi was proud of the prosperity and full employment of his people. This is what he told Dr. Heiser:

"My government has been in continuous existence for over five thousand years. We have no unemployment; we have never had any. We have no starving. All my

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people have homes to live in. They have clothes to wear. They are happy."

In spite of this long record of full employment, I doubt if many Americans would have changed places with Haile Selassi's happy subjects even in 1933. Mass unemployment is a problem only in advanced industrial nations. As in Abyssinia, it is never a problem where industry is backward and production, even with hard labor for long hours, is never sufficient.

The probable size of the labor force and of civilian employment, corresponding with a reasonable interpretation of "full employment" during the immediate postwar years, say for 1947 to 1950, is the question of immediate concern. As with many other situations, involving national statistics, there is no one generally accepted answer. Estimates of the probable postwar labor force have been made by competent statisticians with results that place the total labor force at a minimum of 52 million to a maximum of 62 million in postwar years from 1947 to 1950. This difference of 10 million, and nearly 20%, is all the difference between a continued peacetime labor shortage and an extremely difficult unemployment problem; and this wide difference is caused, quite simply, by the different assumptions made by the different estimators. The arithmetic is the same, but this is the only common factor.

The high estimates start with the U. S. Census figures of employed workers and unemployed workers in 1940 which were as follows:

Employed in March, 1940	45,166,083
Unemployed	7,623,416
Civilian labor force	52,789,499

If the net annual addition to the labor force is assumed to be 650,000 workers, the labor force in March, 1947, would be 57,300,000 workers, and in March, 1950, would be 59,300,000. The most widely publicized estimate, of this size, is the one made by S. Murray Livingston of the Department of Commerce. His estimate of the total labor force, including those in military service, is 59.2 million workers in 1947. Many Government and private authors and orators have adopted this figure. President Roosevelt, in the 1944 campaign, rounded it out to 60 million and confused the question by calling it 60 million "jobs." Unfortunately, the size of the postwar labor force has become a political issue in addition to being a difficult statistical forecasting problem.

All students of this subject agree that the wartime labor force is inflated by the wartime pressures to bring boys, men, and women into jobs who would never have sought work under more normal conditions. For example, the *Labor Force Bulletin*, published by the Census Bureau, discloses almost exactly the same number in the civilian labor force in May, 1944 (52,840,000), as in the labor force according to the Census of 1940. The normal net increase during four years would have been about 2,500,000 workers, but, in these four years, about 11,000,000 men were added to the military forces. This is some measure of the number of workers, from the "hidden labor reserve," school boys and girls, men beyond normal retirement age, and women with families and housekeeping jobs, who have been recruited into the labor force. It is known that approximately 5 million women entered the labor force during the war, above the normal number, represented by the normal percentage of all girls and women, 14 years of age and over.

The approach to this problem that leads to the minimum range of 52 to 56 million is to ignore these abnormal war conditions affecting the labor force and to consider the total population and those parts of the several classes of the population that normally enter the labor force. This method takes into account the trends toward more boys and girls and young men and women continuing their education in high schools and colleges, and more men and women leaving industry at 60 and 65 years of age because of old-age and retirement pensions. This "rough-and-ready" method is illustrated by the figures:*

Census of	Population 14 years and older (millions)	Labor force (%)	Number in labor force (millions)
1920	74.144	55.6	41.236
1930	89.100	54.5	48.595
1940	101.103	52.2	52.789
1945 (est.)	106.438	51.0	54.300
1950 (est.)†	110.000	50.5	55.550

If, for example, the labor force in 1950 were estimated at 60 million, it would mean that 54.5% of the population, 14 years and older, was included in the labor force. This would mean that in 20 years, from 1930, no greater part of the population, 14 and above, would be in school or would have retired. In view of the long-term trends in these two conditions that shorten the average working life of the population, it is not reasonable to expect a working force much above 55 million in 1950.‡

It is believed that these simple methods of estimating, based on past relationships, are a safer guide in view of all the abnormalities and uncertainties in the war figures. Moreover, the actual size of the labor force at any future time will be appreciably affected by the business conditions at the time. In good times the actual labor force will be a smaller percentage of the population, able to work, because more children and young people will be able to stay in school and fewer old people will have to work.

The basis for determination of "full employment" therefore should include a declaration in favor of the advancement of these well-established American social objectives:

(1) The establishment and cultivation of a normal home and family life. This requires a decreasing percentage of married women in the labor force. A high percentage of women in industry is a sign of national poverty.

(2) The extension and improvement of high-school, vocational, and college education for all those who can profit by it. Going back to 1870, only 57% of the children from 5 to 17 years of age were in public schools. Few children above 13 years of age were still in school. By 1940, 85% of the children in the 5–17 age group were in school. In the college-age group, 237,000 were in college in 1900; this number had increased to nearly 1,500,000 in 1940. These trends should be continued.

* This analysis, leading to more conservative estimates, is taken from "Post-War Fiscal Problems and Policies" by John Lee Coulter, Ph.D., Research Adviser, Committee of Americans, New York.

† "Free-hand" extension of these figures by the author.

‡ If total population is estimated at 140 million in 1950, the labor force would be 56 million at the 1940 ratio of the total population in the labor force (40%).

(3) Retirement of older workers should be encouraged by social-security and private pension plans. In 1900, 68.4% of all men 65 years of age or older were working or seeking work; by 1940 this figure had declined to 41.5%. There is still room for desirable reductions.

(4) Adequate provision should be made by Government or private agencies for those unable to work and who need public assistance.

It is an interesting sidelight on this discussion that it is the political liberals—the New Deal, the national labor unions, and other socially minded groups—that arrive at the highest figures for the size of the labor force. It may be that they wish to inflate the problem beyond the ability of private industry to handle the job without Government help. We can have a labor force of 60 million in 1950 (or, with even greater difficulty, 60 million jobs) only if we recruit workers from high schools, colleges, and from among married women and the aged. This would scarcely measure up to the standards of a liberal-social program.

As the next step in this discussion, we need to distinguish between the size of the total labor force and the number of civilians employed. This difference is made up principally of the number of potential workers who will be in military service and the number who are unemployed under the best conditions for all sorts of temporary causes, such as seasonal unemployment, illness, changing jobs, and temporary layoffs. Minimum estimates of these two classes, for 1950, are two million in the armed services, and two million unemployed. The number of civilians employed, under practical conditions of full employment in 1950, using these minimum estimates and a labor force of 56 million, would be 52 million. That is, 52 million jobs in 1950 would provide full employment for a normal labor force and would permit the nation to continue a normal American social program.

The difference between the publicized goal of "60 million jobs" and a more reasonable goal of 52 millions jobs within the next five years is the difference between an attainable objective and one that is impracticable and socially undesirable.*

Industrial expansion in the United States up to 1930 leaves no question about the ability of private industry to provide 52 or 53 million jobs by 1950, if only the same favorable conditions for industrial progress can be restored. We have the experience, the ability, and the capital resources to provide for this reasonable expansion of the labor force and at a constantly increasing standard of living. Until 1930, booms and depressions interrupted the year-to-year progress but did not change the upward trend from decade to decade. During the four decades from 1890 to 1930, gains in the number gainfully employed were 25, 25, 12, and 10%. Following depressed employment, recovery gains have been at a much higher rate. From January, 1933, to January, 1937, for example, employment gained 21.5% in these four years. Again from January, 1938, to January, 1943, employment increased 40% in five years, but under the special inducements of defense and war production. Under the more urgent demands of actual war, employment increased an additional 15% in three years, from December, 1940, to December, 1943. In view of this past experience, a gain in civilian employment from 45.1 million in 1940 to 52 million in 1950, or 18%, should not be impossible, under conditions favorable to individual initiative and capital investment. It is also an objective that provides for the protection of American home life and education.

VICE-PRESIDENT
WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY
PITTSBURGH 30, PENNSYLVANIA

* A most careful detailed analysis of postwar labor force and employment has been made by Rufus S. Tucker, Economist of General Motors Corporation, which is published in the *Conference Board Business Record* for December, 1944–January, 1945, National Industrial Conference Board, New York. Mr. Tucker arrives at a labor force of 58.3 million in 1950 and civilian jobs of 53.3. He estimates unemployment of 3 million and 2 million in the armed forces in 1950.

POSTWAR CONSTRUCTION PROJECT PLANS: A PROGRESS REPORT*

BY THOMAS S. HOLDEN

I. Introduction

There seems to be little reason for worry about the status of postwar construction planning. Already the volume of planned projects, private and public, considerably exceeds any amount likely to get into actual construction in the first twelve months after X Day.

F. W. Dodge Corporation's field staff reported, up to December 31, 1944, for its thirty-seven states territory, 71,564 specific projects contemplated for the postwar period, at a total estimated cost of $13,254,848,000. Of these projects, 25,319 were reported as being in the design stage, their total estimated cost being $6,378,486,000.

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The total of more than six billion dollars of planned work is properly comparable, not with such over-all construction estimates as those put out by the Department of Commerce covering the entire United States, but with the factual tabulations of contracts awarded in the same territory covered in the V Day project tabulation, the thirty-seven eastern states. The dollar volume of planned postwar projects exceeds the total contract volume for the year 1938 by 99%, the contract volume of the year 1939 by 69%, the contract volume of 1940 by 49%. For reasons to be explained later, I believe the actual volume of new construction that can actually get started in the first 12 months after X Day will likely approximate the volume of the year 1938, which had the smallest volume of any of the three years I have used for comparison.

Detailed analysis, by dollar volumes of postwar planned

work and actual 1938 contracts, brings out some interesting points. The comparative figures follow:

CONSTRUCTION IN THIRTY-SEVEN EASTERN STATES

	Planned for postwar	1938 actual
	PRIVATE	
Nonresidential	$1,150,031,000	$ 499,819,000
Residential	694,779,000	899,561,000
Heavy construction	174,156,000	92,828,000
Total Private	$2,018,966,000	$1,492,208,000
	PUBLIC	
Nonresidential	$ 927,510,000	$ 572,318,000
Residential	207,721,000	86,226,000
Heavy construction	3,224,289,000	1,046,176,000
Total Public	$4,359,520,000	$1,704,720,000
Grand Totals	$6,378,486,000	$3,196,928,000

These figures show that the distribution pattern of work, by general classes, in the table of planned work is quite out of line with the pattern of the year 1938; the volume of planned postwar private residential work is much too small, the volume of public heavy construction is large out of all proportion to a balanced program. In fact, the year 1938 cannot be said to have had a balanced program, since its proportion of public construction in the total was considerably greater than in a normally prosperous peacetime year. In such a prosperous year, public construction expenditures might run between a quarter and a third of the total.

As to the apparent deficiency in planned private residential building plans, there is no cause for worry; it is a statistical deficiency, not a real one. Most single-family house projects are normally started with only a brief period of advance planning. Therefore, while they constitute one of the most important construction classifications, the amount of advance data that can be secured represents only a sampling of the potential market. With conditions favorable to house-building and with this nucleus of statistically recorded plans, private residential building may be counted on to play a very large part in the construction activity of the early postwar years. The volume of individual savings in the country, the vast funds of mortgage money seeking outlets, and the special encouragement to home acquisition given to veterans under the GI Bill of Rights are likely to add up to a combined demand greater than the industry can supply for at least several years.

The statistical picture on planned public work is quite different from that of planned private residential building. If we add together the planned public projects of all three classes (nonresidential, residential, and heavy construction), we get a total of $4,359,520,000, which is an amount greater than the total dollar volume of all private and public contracts in any of the years 1938, 1939, or 1940. If I am right in my guess that transitional bottlenecks will limit construction activity during the first twelve months after X Day to something like the 1938 volume, it is obvious that the public work already planned, if put under contract immediately or shortly after X Day, would tend to crowd out every potential private project on our list.

This is admittedly a rigidly mathematical interpretation of statistics on futures and should not be taken too literally. Properly viewed, it is an illustration of the point I want to make: that artificial stimulation of public works in the early postwar period can scarcely fail to intensify competition with private projects for needed man power and materials. This potential situation has been recognized by high authorities in Washington. In a report to the President on September 7, 1944, War Mobilization Director Byrnes said, "The demand for construction projects exists. As a rule those governments (i.e., states, counties, and cities) have the funds for the projects. In communities where there is no unemployment following VE Day it would be unfortunate if large public works were undertaken. It would be more unfortunate if they were not undertaken in communities where there is unemployment." Favoring quick letting of private contracts is the fact that private projects are always planned for particular sites already owned or controlled, whereas many public projects depend on future acquisition of sites or rights-of-way.

It should also be pointed out that our list of planned projects has been growing since the first of the year, nearly $300,000,000 having been tabulated in the month of January. It should also be noted that the figures that have been presented include no deferred maintainance, repair, or minor modernization jobs, potentially a very large postwar market factor.

It is obvious, not only from figures on planned work but also from what we know of accumulated shortages and deferments, that potential demand for construction is very large indeed—so large, in fact, that it will be a matter of several years before the country can get caught up. After World War I, it took six years, but then the revival period was stretched out by reason of a two-year, price-deflation depression in 1920 and 1921; this made a net recovery period of four years. It will, of course, be recalled that the revival, or catching-up period, after World War I, was followed by five years of general business expansion and record-breaking construction activity.

II. X Day

The question being discussed in this paper is construction after X Day. Perhaps I should explain the term X Day. We have been accustomed to the term VE Day as designating the day of victory in Europe and VJ Day to designate the day of victory over Japan. The term X Day has been devised to take care of the contingency that the whole German army and nation may not surrender on a particular day, but that German resistance may disintegrate gradually. In that case, X Day would be the day when our general staff decides that the war is so completely won that it can issue wholesale cancellations of war orders and permit a sizable amount of industrial reconversion to start.

III. Three Phases of Revival

It seems likely that, after restrictions are removed or lightened, construction revival will progress through three phases, gradually at first, and then with accelerated velocity.

The first, or reconversion phase, will last three to six months from X Day. Deferred maintenance, repair, alteration, and modernization will move ahead as fast as men and materials become available. (Maintenance and

repair work and the smaller alteration and modernization jobs will not appear in the contract record.) In addition to deferred work on practically all other classes of existing structures, appreciable amounts of construction will be involved in reconverting war plants. Strong demand pressure will make for an early start on house building, particularly houses for owners' occupancy, either on owners' order or by operative builders for sale. Preponderance of early demand will be for houses in middle rather than low-price ranges. Heavy engineering construction, using principally noncritical materials and unskilled labor, would make an early start; a possible bottleneck may be shortage of transportation facilities, rail and truck. This phase will likely see a start at letting of contracts for public building projects, particularly, urgently needed community facilities which can be started by states and local governments. Federal hospital projects for veterans will probably get under way.

The second phase will consist principally in a snowballing of contracts for new construction of the kinds that have already begun to appear in the first phase, with increases both in number and variety of projects. Store modernization is likely to increase considerably. There is likely to be a great increase in contracts for new factory building for nonwar industries. Total contract volume is likely to increase month by month, both in building and heavy engineering categories. This phase will extend well beyond VJ Day and beyond final removal of all Government controls. It will therefore more than likely extend more than twelve months beyond VE Day (or X Day).

The third phase will begin after rent controls are lifted practically everywhere and after construction costs have become relatively stabilized, giving assurance to investors that rental projects can safely proceed. In this phase, apartment building will increase greatly. If by that time office space released by demobilization of Government war agencies and special war business has been absorbed, new office buildings may begin to appear in contract listings. Larger store and factory buildings will come along, and larger numbers and varieties of public building projects. Barring shortages of skilled labor, revival will by that time be very substantial in magnitude and unlimited by controls or economic bottlenecks.

While this three-phase schedule is the more or less obvious order in which revival will take place, there is no absolute assurance that revival will mount continuously without interruption. Price confusion after ceilings are lifted could be of such proportions as to cause a more or less serious interruption. At some time in the third phase there may develop shortages of skilled building craftsmen. Strikes for wage increases might occur at any time, more likely in the second or third phase than in the first.

The obvious reason for anticipating a slow revival in the early phases is found in the existence of four important, though temporary, recovery bottlenecks, which are widely known to exist. These bottlenecks are (1) Government controls, (2) material supply problems, (3) price problems, and (4) man-power problems.

IV. Government Controls

Wartime controls on construction volume are of six kinds, as follows: (1) limitation orders forbidding all except officially approved categories of construction (war construction plus essential civilian projects); (2) raw material allocations and production controls, which limit overall quantities of construction materials available, with rationing of scarce materials for various essential uses, (3) man-power controls, (4) price controls, (5) wage controls, and (6) rent controls.

The first three have the purpose of concentrating on production for total war; the last three have to do with inflation control.

Relaxation of construction limitation orders started in a small way last fall. Alterations in houses and apartment buildings consisting in subdividing the space to produce additional family units have been permitted during the past several months. On October 16, 1944, the National Housing Agency announced liberalization of certain restrictions on use of materials for new houses. These relaxations were granted at a time when many people thought the war in Europe would be over by the end of 1944. At the present time, it does not look as if there would be any further relaxation before X Day, if indeed the previous minor relaxations are not rescinded.

Rent ceilings have been applied on an area basis and will be lifted the same way. Until they are actually lifted and residential rents find their level in a free market, little rental housing will be undertaken. Investors must see ahead a prospect of rent income promising an adequate return on land costs, construction costs, and operating and carrying charges.

V. Material Supply Problems

In addition to the question of removal of controls, there will be for several months after X Day a question of adequate supplies of certain important construction materials and equipment.

There are likely to be temporary shortages of dimension lumber and of building-equipment items fabricated from the metals. Masonry materials of all kinds are apt to be in ample supply.

Lumber production has held to high levels during the war, in spite of shortages of man power, machinery and tools, trucks and tires. Shortages have been due to enormous wartime consumption, including boxes and crates and lumber shipped abroad for military construction purposes. Military demands will decrease after X Day, but will continue at fairly high levels until Japan is defeated. The extent of foreign reconstruction demand that may be taken care of by the American lumber industry is not known at this writing. While some predictions as to postwar lumber shortages have appeared to have an exaggerated alarmist tinge, this vital material is apt to be an important controlling factor in construction, particularly house building, for twelve months after X Day.

Various surveys have indicated that three to six months will be required, after green lights have been given, to produce supplies adequate in quantity and variety of such fabricated items as metal windows, plumbing fixtures, heating equipment, and builders' hardware. As for electrical supplies, only a short time will be required to get many of the commoner items into full production, but it is likely to take some months to build up inventories of the 2000 active items normally kept in stock continuously. Presumably these estimates of reconversion time assume

favorable conditions, without strikes or other unforeseen interruptions.

Apparently, construction machinery equipment will be adequate for the volume of construction likely to develop in the first twelve months after X Day, but potential demand for new machinery and equipment will be very great and difficult to meet for a time as construction revival progresses.

VI. Price Problems

Price problems may exist during the period of material shortages, their extent at that time depending upon price-control policy and the effectiveness of its administration. Even if material prices and building-labor wage rates appear to be steady during the months directly after X Day, there may be some hesitation on the part of the investing public due to doubts about price trends of the future.

After World War I, expectation of declines from wartime price levels caused investors to hesitate about letting construction contracts. After a waiting period demonstrated that construction costs were not going to decline appreciably, prices rose and the full flood of uncontrolled demand brought about a serious price inflation, in which construction materials participated along with all other commodities. The subsequent price collapse was accompanied by a short but very severe depression, seriously interrupting construction revival.

Confusion in price trends may be greater after all controls are lifted than during the transition period. If, at that time, self-control on the part of material producers and suppliers and building labor can hold building costs reasonably well in line, the investing public will be reassured and recovery will be facilitated.

The industry has a continuing obligation to watch prices, wages, and construction costs through the transition period and thereafter. Even after construction has revived to a substantial degree, a situation could arise when construction costs would be out of line with general commodity prices and would discourage private investment.

VII. Man-Power Problems

While there is unemployment currently among building craftsmen, in certain trades and in particular localities, the situation is spotty. Many building craftsmen have gone into the armed services, shipbuilding, war production; this happened after an extended depression period when few apprentices were trained and admitted into unions to replace older men who ceased to be active. On the other hand, many returning veterans who were not previously employed as construction workers will have acquired in their army and navy training the skills qualifying them for construction work; however, these men will not be available in numbers immediately after VE Day.

While much blueprinting activity is currently going on, there are shortages of draftsmen. It will take some time to recruit men for logging camps and factories. Most offices of architects and engineers and the contractor organizations are standing by, ready to expand their activity very quickly, but even they will scarcely be able to staff their organizations overnight. Man-power supply will probably not be a major bottleneck for any extended period, but in the early weeks and months following VE Day it may be a factor contributing to slowness of construction revival.

VIII. Moderate Revival in First Postwar Year

These bottlenecks constitute the reasons for my belief that, in spite of enormous potential demand, actual construction volume in the first twelve months after X Day is likely to approximate the volume of the year 1938, the one whose contract record I used for comparison with the figures on planned postwar projects. The 1944 volume of contracts in the thirty-seven eastern states was $1,994,000,000, or practically two billion dollars. The 1938 volume which I expect to be duplicated approximately in the first twelve months after X Day, was $3,197,000,000, just 60% more than the 1944 volume.

This estimate on construction volume during the first twelve months after X Day was made last November, in lieu of the customary Dodge estimates for the ensuing year. At that time it seemed possible that hostilities might be over in Europe by the end of 1944, in which case the calendar year 1945 would coincide with the period supposed to be covered in the estimate. That possibility no longer exists.

We said in November that if X Day should come in March, 1945, then the X Day estimates reduced by 20% would fit the calendar year 1945; we also said that if X Day should come as late as June 1 of this year, the 1945 construction volume would approximate the volume of 1944.

It now seems advisable to take into account still another alternative situation, the possibility that the war in Europe will continue until near the end of this year. In that case, curtailment of 1945 activity below the 1944 rate may be expected, perhaps 10 to 15%. Then the estimates for the first revival year would apply to the calendar year 1946.

It is obvious to everyone by now that it is not possible to time the beginning of construction revival; the industry is simply holding itself on a stand-by basis until the moment when the green light can be flashed. In the meantime the volume of planned postwar work is increasing daily.

PRESIDENT
THE F. W. DODGE CORPORATION
119 WEST FORTIETH STREET
NEW YORK 18, N. Y.

A SHOCK TO THE IMAGINATION

Research is being discussed at every turn. Two sectional institutes of research have been established in the past few months. Older institutions are flooded with projects and have expanded facilities to meet the demand. Research means progress.

Theodore G. Klumpp, speaking at a symposium of the Division of Medicinal Chemistry of the American Chemical Society, said that we are just beginning to see the possibilities of research in body chemistry. American chemical investigators are now ahead of the Germans. They are tackling the problems of human ills in the organized manner of the research scientist.

You will enjoy reading Dr. Klumpp's talk as published in *Chemical & Engineering News*, January 10, 1945. From it you may get ideas of how ceramic reserach should be carried on.

LOCAL SECTION NEWS

BALTIMORE-WASHINGTON SECTION

The winter dinner meeting of the Baltimore-Washington Section was held February 17, 1945, at the Hotel Continental in Washington, D. C., with Vice-Chairman J. C. Richmond presiding.

It was announced that our spring meeting would be held June 2, 1945, in Baltimore. The principal speaker at this meeting will be James Hillier of the R.C.A. Laboratories who will talk on the subject "The Electron Microscope and Further Developments in Microanalysis." Election of Section officers for 1945–1946 will also be held at this time.

A nominating committee consisting of R. F. Geller, *Chairman;* G. R. Shelton, and W. A. Weldon was appointed.

E. H. Fritz, President of The American Ceramic Society, told how the cancellation of the technical sessions of the Forty-Seventh Annual Meeting will create very serious problems for The Society since the Annual Meeting provides the bulk of the material for The Society's publications. He mentioned that without adequate publications the strength and value of The Society would rapidly decrease. He suggested that we plan to make our June 2 meeting a larger affair with possibly an afternoon and evening session. During the afternoon session, papers could be presented which ordinarily would have been given by members from this Section at the Forty-Seventh Annual Meeting and the evening session could consist of our regular dinner meeting with a talk by our guest speaker, Dr. Hillier of the R.C.A. Laboratories.

A committee was appointed to make plans for carrying out the suggestions of Mr. Fritz for enlarging our spring meeting. This committee consists of W. W. Coffeen, *Chairman;* L. J. Trostel, and W. A. Weldon.

W. N. Harrison, Chief of the Enameled Metals Section of the National Bureau of Standards, talked on "The N.B.S. Ceramic Coatings of Exhaust Systems." He described these coatings and mentioned that interest in them has rapidly grown since their practicability has been proved and especially since they are getting into production on an increasing number of air, land, and sea vehicles used by the armed forces. Samples were available for inspection and a demonstration of a thermal-shock test used in the development of these coatings was given.

The Bureau of Mines Film, "The Story of a Spark Plug," was shown. This film showed the complete manufacture of a spark plug from the mining of the sillimanite in California to the final assembly and testing.

—C. B. SHELLEY, *Secretary*

CENTRAL OHIO SECTION

Panel of Ceramists Discuss Future of the Industry

A group of ceramists was asked questions and gave answers on important ceramic problems at the meeting of the Central Ohio Section held in Columbus March 2, 1945. The panel consisted of H. H. Blau, Federal Glass Company; George D. Brush, Harrop Ceramic Service Company; J. O. Everhart, Engineering Experiment Station, Ohio State University; R. M. King, Department of Ceramic Engineering, Ohio State University; John D. Sullivan, Battelle Memorial Institute; C. Forrest Tefft, Claycraft Company; and Charles S. Pearce, The American Ceramic Society.

Most of the questions dealt with economic factors in the ceramic industry, especially the competition of other materials. The possibilities of research in both materials and processes were considered to be an important influence on the future of ceramic products. Everyone on the panel expressed optimism on the postwar outlook for the industry.

Two films were shown, one of the Army in action and the other of the building of a B-29 bomber.

There were sixty-six present, including members from Pittsburgh, St. Louis, Baltimore, and Chicago, as well as from China, Brazil, and Canada.

Chairman W. E. Cramer closed the meeting with the announcement that the next meeting would feature some of the papers which were to have been presented at the Annual Meeting.

NORTHWESTERN OHIO SECTION

The Permanent Organizing Committee, appointed by the Acting Chairman at the first meeting of the Section, met March 2 to draw up the Rules of the Section, to elect officers, and to lay plans for the remainder of the season.

Present were A. H. Couch, Chairman; D. E. Sharp, O. G. Burch, Howard Morison, H. H. Holscher, Robert Twells, R. K. Day, H. A. McMaster, R. W. Wampler, and A. H. Nieman. Unable to attend were U. E. Bowes, V. W. Boeker, and R. A. Schoenlaub.

The Rules, as drawn by the Committee, will be presented to the next meeting of the Section for ratification. There was unanimous agreement that nonmembers of The American Ceramic Society should be encouraged to affiliate with the Section, with the privilege of voting but not of holding elected office.

Officers elected for the remainder of this year and for next year are as follows:

Councillor: ROBERT TWELLS, Electric Auto-Lite Co., Spark Plug Div., Fostoria, Ohio.
Chairman: A. H. COUCH, Libbey-Owens-Ford Glass Co., Rossford, Ohio.
Vice-Chairman: H. H. HOLSCHER, General Research Lab., Owens-Illinois Glass Co., Toledo, Ohio.
Secretary: H. A. MCMASTER, Libbey-Owens-Ford Glass Co., Toledo, Ohio.
Treasurer: HOWARD MORISON, Owens-Corning Fiberglas Corp., Toledo, Ohio.

An April meeting in Toledo is being planned, (see p. 149), and it was tentatively decided that arrangements be made for a meeting in the early summer in a city on the southern border of the Northwestern Ohio area.

—A. H. COUCH, *Chairman*

PITTSBURGH SECTION

On March 13, 1945, a buffet dinner was served to 72 persons at the Webster Hall Hotel preceding the regular meeting at Mellon Institute which approximately 80 attended.

A short business session was held at which the secretary was requested to investigate the cost of publishing schedules of our regular monthly meetings in the Pittsburgh Technical Calendar. Ralston Russell, Jr., moved that the chairman appoint a committee to study the improvement of relationship between the local group and the National Society. This motion was passed and our chairman, Harold Simpson, appointed A. P. Thompson as chairman of this committee with the following additional members: E. Ward Tillotson, J. S. Gregorius, Ralston Russell, Jr., E. H. Fritz, Theodore Lenchner, F. C. Flint, and W. Keith McAfee.

George J. Bair of the Research Department of the Corning Glass Works, Corning, N. Y., gave a very interesting informal talk entitled "Glass, the Custom-Built Material." This talk covered the various properties which can be incorporated into different glasses. He also brought a large collection of specimens with him to explain his talk further. A number of slides were shown showing the properties of glasses, including a few special slides injected by the local group.—HOWARD M. PARKHURST, *Secretary*

NORTHERN CALIFORNIA SECTION

A meeting of the Northern California Section of The American Ceramic Society was held at the Hotel Claremont, Oakland, Calif., March 6, 1945.

The meeting was called to order by Chairman Bradley W. Wyatt at 8:45 P.M. Music and songs were enjoyed by the group.

T. K. Cleveland, of the Philadelphia Quartz Company, reported on a meeting of the Committee on Research and Education with two members of the faculty of the School of Mines, University of California, for the purpose of making a survey in the Pacific Coast area to determine what interest the ceramic industry might have in a proposal to establish a four-year course in ceramic engineering on the Berkeley campus. In making such a survey, the School also wished to have information on the prospective need for ceramic-trained men during the next ten years. It was the opinion of the School of Mines' representatives that members of the Northern California Section of The American Ceramic Society were in a much better position to make a reliable survey because of close contacts with the industry. It was agreed that members of the Northern California Section should therefore undertake this survey and correlate the replies into the form of a report to be submitted to the Dean of the School of Mines for further action.

Chairman Wyatt appointed the following members: Albert S. Adcock, American Radiator & Standard Sanitary Corp.; L. N. Gill, American Radiator & Standard Sanitary Corp.; and Graham Smith, Kraftile Company, to study the Local Section Rules as amended and accepted by the Board of Trustees. This Committee is to report what effect, if any, these new Rules will have upon our Local Section.

The speaker of the evening, Chuck Kraft, of Kraftile Company, gave an interesting talk on "Modular Planning as Related to Building Design."

The meeting was adjourned at 10:15 P.M.

—P. C. VALENTINE, *Secretary*

PITTSBURGH SECTION

Spring Meeting

Friday, May 11, 1945 2:00 P.M. Mellon Institute

Chairman: H. E. SIMPSON, Mellon Institute, Pittsburgh 13, Pa.
Vice-Chairman: J. W. JORDAN, Mellon Institute, Pittsburgh 13, Pa.
Secretary: H. M. PARKHURST, General Refractories Co., Pittsburgh 22, Pa.
Treasurer: LOUIS A. SMITH, Jones & Laughlin Steel Corp., Aliquippa, Pa.

2:00–2:30 P.M.

(1) "War Veterans in the Postwar Ceramic Industry" by J. E. EAGLE, Chief, Non-Metals Section, Miscellaneous Minerals Division, WPB, Washington 25, D. C.

2:30–3:00 P.M.

(2) "Microstrength of Glass" by H. W. POWELL AND F. W. PRESTON, Preston Laboratories, Box 847, Butler, Pa.

3:00–3:30 P.M.

(3) "Flow Lines in a Continuous Melting Glass Furnace as Determined by Cobalt Oxide and Pictured in Color Photographs" by VERNON W. LENZ, Owens-Corning Fiberglas Corp., Newark, Ohio.

3:30–4:00 P.M.

(4) "Recuperation in Direct-Fired Tunnel Kilns" by PHILIP DRESSLER, Swindell-Dressler Corp., Pittsburgh 30, Pa.

4:00–4:30 P.M.

(5) "Development of Zircon as a Versatile Ceramic Material" by N. R. THIELKE AND H. W. JAMISON, Orefraction, Inc., Pittsburgh 8, Pa.

4:30–5:00 P.M.

(6) "X-Ray Diffraction Data for Compounds in the $CaO–MgO–SiO_2$ System" by C. BURTON CLARK, Harbison-Walker Refractories Co., Pittsburgh 22, Pa.

6:30 P.M.

Dinner at the University Club, 123 University Place (two blocks from Mellon Institute), followed by entertainment and sociability for the ladies.

Committee in Charge

ARTHUR A. WELLS, *Chairman*, Homer Laughlin China Co., Newell, W. Va.
NORBERT S. GARBISCH, Garco Products, Inc., Butler, Pa.
W. KEITH MCAFEE, Universal Sanitary Mfg. Co., New Castle, Pa.
FRANCIS C. FLINT, Hazel-Atlas Glass Co., Washington, Pa.

CHICAGO SECTION

The Chicago Section held an all-day session April 7, 1945, at the LaSalle Hotel, Chicago, Ill.

As the Annual Technical Meeting has been postponed, the Section presented some of the papers which should have been presented at the Meeting. They are as follows:

(1) "Porcelain Enamel, the Versatile Finish" by F. L. MEACHAM.

(2) "Classification of Typical American-Made Figurines" by J. J. SVEC.

(3) "Use of Wood Ash in a Low-Fire Mat Glaze" by H. L. THURN.

(4) "Factors Influencing Fluxing Action of Various Oxides in Low-Temperature Borosilicate Glasses" by H. R. SWIFT.

(5) "Comparison of Gouging Characteristics of Various Surfaces" by R. L. COOK.

(6) "Properties and Uses of Several Clays in Porcelain Enamels" by R. L. COOK.

(7) "Crazing of Electric Stove Tops in Service" by R. L. FELLOWS.

(8) "The Infrared Principle, What It Is and What It Does" by W. H. TESMER.

(9) "Some Clay-Water Properties of Certain Clay Minerals" by R. E. GRIM and F. L. CUTHBERT.

(10) "Insulation in the Portland Cement Industry" by R. A. WITSCHEY.

E. H. Fritz, President of The American Ceramic Society, spoke at a luncheon held at noon.

NOTE: This meeting was held with 107 present. The Chicago District Enamelers' Club cooperated.

SOUTHERN CALIFORNIA SECTION

A meeting of the Southern California Section of The American Ceramic Society was held March 6, 1945, at the Baux Restaurant, Los Angeles, Calif. Our attendance was seventy-eight.

Benjamin Borchardt, of Benjamin Borchardt and Associates, spoke on "The Problems of Applying Wage Incentives."

Election of officers was held with the following result:

Chairman: CLARE S. CHAFFEE, Latchford-Marble Glass Co., Los Angeles, Calif.
Vice-Chairman: C. GUY WURTSBAUGH, Haldeman Potteries, Burbank, Calif.
Secretary-Treasurer: W. O. BRANDT, Gladding, McBean & Co., South Gate, Calif.

—C. GUY WURTSBAUGH, *Secretary*

NORTHWESTERN OHIO SECTION

The Northwestern Ohio Section will meet Wednesday, April 25, 1945, at the Yacht Club, Toledo, Ohio.

Francis C. Flint, Hazel-Atlas Glass Co., Washington, Pa., will be the speaker.

LOCAL SECTIONS

The Local Sections of The American Ceramic Society have a large place to fill this year. They are conducting the only meetings where members can get together to discuss ceramic problems.

Every society with strong local sections has found them useful in holding member interest at this time when national meetings are impossible. Many societies with weak sections are reorganizing them; one society with no local sections is hastily putting them together.

One-half of the members of The American Ceramic Society are within the areas covered by the twelve Local Sections. These members can attend one or two technical meetings yet this spring. Meetings in April, May, and June will be especially interesting.

This is one of the strongest points for membership in The Society. New members can get acquainted easily.

Bring them with you!

PAID MEMBERSHIP AND SUBSCRIPTION RECORD

Date of Record	Members Paid		Deferred	Subscriptions	Monthly Sales	Total Circulation
	Personal	Corporation				
March 21, 1944	1844	323	4	523	220	2914
December 21, 1944	2317	402	2	661	220	3602
January 21, 1945	2368	404	3	670	220	3665
February 21, 1945	2409	408	2	688	220	3727
March 21, 1945	2103	391	3	647	220	3364
12-month % increase	14%	21.1%		23.7%		15.4%

NEW MEMBERS IN MARCH

Corporation

BRICKSEAL REFRACTORY CO., Rexford Newcomb, Jr. (voter), 1029 Clinton St., Hoboken, N. J.
FIBERGLAS CANADA, LTD., Oshawa, Ontario, Canada.
HAVILAND, THEODORE, & Co., INC., Theodore Haviland II (voter), 26 West 23rd St., New York 10, N. Y.
LISK MANUFACTURING CO., LTD., Ashley F. Wilson, Jr. (voter), Canandaigua, N. Y.
MEDALTA SALES B. C. REG'D., B. A. Cunliffe (voter), 29 W. Pender St., Vancouver, B. C., Canada.

Personal

BAKER, THEODORE C., 41 Crestview Dr., Newington, Conn.; research physicist, Hartford-Empire Co.
FISK, DAVID, 225 Fifth Ave., New York, N. Y.; eastern sales manager, Gonder Ceramic Arts, Inc.
*FLEMING, A. P. M., Metropolitan-Vickers Electrical Co., Ltd., Trafford Park, Manchester 17, England; director.
*HOLLEY, KENNETH E., 72 Bissell Ave., Corning, N. Y.; ceramic engineer, Corning Glass Works.
KALEY, MARY E., Box 257, Watsonville, Calif.; Permanente Metals Corp.
MORELL, N. L., 313 Union Bank Bldg., Bethlehem, Pa.; manufacturer of insulating materials.
SPURCK, RICHARD F., 832 Hampton Ave., Schenectady 8, N. Y.; U. S. Army.
STEWART, MALCOLM, 310 Irwin St., San Francisco, Calif.; secretary and treasurer, Commercial Minerals Co.
WASCHLER, ALBERT L., General Refractories Co., Box 1673, Baltimore 3, Md.
WRIGHT, RUSSEL, 7 Park Ave., New York, N. Y.; designer.

Student

Iowa State College: JOSEPH A. BURNS.
University of Illinois: WEN-TE YU.

* Indicates former member of The Society rejoining.

MEMBERSHIP WORKERS' RECORD

CORPORATION: Rexford Newcomb, Jr. 1, F. A. Petersen 1, Hewitt Wilson 1, Office 2.
PERSONAL: Lawton Gonder 1, William Horak 1, R. C. Hutchison 1, Theodore Lenchner 1, C. B. Shelley 1, R. K. Smith 1, L. E. Thiess 1, Office 3.
STUDENT: C. M. Dodd 1, H. R. Swift 1.
GRAND TOTAL: 17.

ROSTER CHANGES IN MARCH*

ALLOR, ALLEN M., R. D. 1, Antioch, Ill. (Chicago, Ill.)
ALT, LESLIE R., Kraftile Co., Niles, Calif. (Sioux City, Ia.)
ALVAREZ, JUAN H., Calle 62 No. 47–24, Medellin, Colombia, South America (Columbus, Ohio)
BRANDT, WILLIAM O., Gladding, McBean & Co., South Gate, Calif. (Pittsburg, Calif.)
COHEN, ARTHUR, Sylvania Electric Products, Inc., 83–30 Kew Gardens Rd., Kew Gardens, N. Y. (Emporium, Pa.)
CZOLGOS, EDMUND P., Century Vitreous Enamel Co., 6641 S. Narragansett Ave., Chicago, Ill. (Oak Park, Ill.)
GOOCHEE, HERMAN, 1607 Ligonier St., Latrobe, Pa. (Raleigh, N. C.)
HELSER, PERRY D., Gladding, McBean & Co., 2901 Los Feliz Blvd., Los Angeles 26, Calif. (White Plains, N.Y.)
HUNTER, CHARLES E., Box 966, Asheville, N. C. (Knoxville, Tenn.)
MITCHELL, LT. (JG) LANE, 2065 N. Glebe Rd., Apt. 104, Arlington, Va. (Cambridge, Mass.)
ROGERS, EDWIN J., Marshall-Eclipse Div., Bendix Aviation Corp., Troy, N. Y. (Columbus, Ohio)
ROSS, DONALD W., U. S. Bureau of Mines, Univ. of Alabama, Tuscaloosa, Ala. (Hyattsville, Md.)
SCHWARTZ, FREDERICK W., 1035 E.—6 North, Provo, Utah (Homestead, Pa.)
TEFFT, PHILIP W., 1381 W. Sixth Ave., Columbus 8, Ohio (Blacklick, Ohio)
VENABLE, CHARLES R., 933 Watauga St., Kingsport, Tenn. (Pittsburgh, Pa.)
WEST, LT. (JG) CARL, JR., Hunter's Point, San Francisco, Calif. (Rochester, Minn.)
YOUNG, RT 3/c S. H., U.S.N., c/o Mrs. G. B. Young, 143 Hirst Ave., East Lansdowne, Pa. (Canton, Ohio)

* Address in parentheses is former address.

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MEMBERS IN SERVICE*

The following members of this Society are in fighting units of war service. There are several in service in Washington not included in this Service Roster. This list, which was begun September, 1942, and added to each succeeding month, is probably not complete, and we would appreciate information on other members.

(420) JOSEPH A. BURNS, Iowa State College, Ames, Iowa.
(421) ALBERT J. CATON, JR., Basic Magnesium, Inc., Las Vegas, Nevada.
(422) JEWEL KARPEL, New York State College of Ceramics, Alfred, N. Y.
(423) PAUL S. MAYBAUM, JR., Rutgers University, New Brunswick, N. J.
(424) PAUL H. REED, Pennsylvania State College, State College, Pa.
(425) RICHARD F. SPURCK, Pennsylvania State College, State College, Pa.

* These are in addition to the lists published monthly, beginning with the September, 1942, *Bulletin*, with the exception of the June, 1943, issue.

★ LETTERS FROM SERVICEMEN ★

San Francisco, Calif.,
24 February, 1945

Dear Ross:

Thanks for the Christmas card from you and the office staff of The Society. I enjoy your monthly bulletins to the service members. It is good to learn what is going on back home, especially when there is no time to read the technical works. Someday I hope to be back home so that I can live a normal life again.

Out here there is little time for anything but work. Battles are hard on the ships which participate. It is our job to keep the ships floating and the planes flying. It is most interesting to be always in contact with the war as it progresses. In order to do our job right, time means nothing except as a period when we can use our facilities to best advantage. We are on the job seven days each week with many evenings thrown in.

Best wishes to you, Fritz, and the staff for a most successful 1945.

Sincerely,
LESTER M. MERRITT,
Captain, U. S. Navy

★

Wrightstown, N. J.,
5 February, 1945

Dear Mr. Ross:

Before entering the service I studied ceramics at Alfred University. I am very much interested in keeping in close contact with the ceramic field and would appreciate it if you would send me your monthly News Letter. Thank you.

Sincerely,
SEYMOUR BLUM,
Private, Army Air Forces

★

New York, N. Y.,
2 February, 1945

Dear Ross:

I have been receiving all of your letters and notes from The Society and have been trying to gain the time and energy to answer and let you hear from me.

I have been overseas since July. I spent about four months in England and now I am somewhere in France. I can truthfully say that I like the good old U.S.A. better than anything I have seen since I left there. There is not much I can tell you about France and what I am doing. I am in command of a Port Company (whatever that is) and have been for about a year now. I have noticed on all of your letters that you have addressed them as "Capt." I am not a captain yet but hope that it will not be long.

I am very much interested in seeing this war end so I can return to civilian life and to my study of ceramics. I plan to go back to Virginia Polytechnic Institute and take a year of review and postgrad work. It is almost a necessity since being away from the study and work for these two and one-half years. Professor Whittemore writes me that they are planning to have such a course for the returning ceramic engineers. I think it is a wonderful plan to aid those of us who never had the chance to get commercial experience in ceramics.

I think my wife has sent you a check covering next year's, or should I say this year's, dues. You can continue to send the publications to the address in Virginia, Any material that you feel would be of interest to me at the time of mailing I would like to have mailed to me at my Army address. I will try to be a little more prompt to give you any change of address in the future.

I received the Christmas greeting and am very grateful for it. It makes one feel good when he knows everyone at home is behind him in this conflict.

I haven't much time left and must get busy with some other work, so I will bring this letter to a close.

Very sincerely,
RALPH V. LAWRENCE,
First Lieutenant, U. S. Army

★

San Francisco, Calif.,
28 February, 1945

Gentlemen:

Enclosed please find my personal check for twelve dollars ($12) to cover payment of my dues for the present year. I do not know whether or not you have sent me a notice that payment was due, for as yet no mail that has been forwarded has caught up with me. I am anxious to keep a full library of *The Journal* and *Bulletin*, so if by any possibility the subscriptions have been stopped, I should greatly appreciate it if you would mail the missing copies to my home address. I sincerely trust that I'll be able to keep a much more active interest in The Society in the not-too-distant future, but I guess this job out here has to be finished first.

Please use my home address, 227 Clay St., Reno, Nev., for all correspondence. Thank you very much.

Sincerely yours,
ALBERT J. CATON, JR.,
Lieutenant (j.g.), U. S. Naval Reserves

★

Arlington, Va.,
8 March, 1945

Gentlemen:

As has probably been the case with many other ceramists, since entering the Navy in late 1943 I have found it difficult to concentrate on the war to the complete exclusion of ceramics.

Of course, this is probably only natural, as ceramic engineers have practically "breathed, eaten, and slept" ceramics for years prior to "joining up." In the lulls between military activities, probably most of us have done considerable day-dreaming about what we intend to do when we get back to ceramics again.

Fortunately, I have been able to partly keep in touch with ceramics, by newspaper articles, a few A.C.S. *Journals* and news letters, plus some ceramic magazines These go a long way toward keeping up your morale by definitely showing that this industry is still alive and kicking.

It looks to me as if the ceramic industry will certainly not lag behind other industries in the postwar upsurge, but instead it should be up among the leaders, due to the boost of new developments uncovered incident to the war. However, this is not necessarily "unconditionally guaranteed," since both the quantity and quality of this will depend on the determination and "imagineering" of the leaders of this industry, which in many cases means the ceramic engineers.

Unfortunately, although the Navy uses many ceramic materials, such as dinnerware, glass products, refractories, abrasives, thermal and electrical insulators, structural ceramics, etc., there are not many officers who get a chance to work with these products. I gained some shipbuilding and repair experience at the Philadelphia Navy Yard and at Cape May Naval Base, N. J. I have been in the Bureau of Ships here in Washington since last summer.

I have just read with interest some letters from servicemen-ceramists to Ross and The Society, in response to his requests. These seem like a good poll of opinions and suggestions "from where they stand"—and contain several worth-while comments.

It seems highly probable that "there'll be some changes made" in ceramic as well as most other curricula. The

war's effect and focus upon realities will likely make it necessary for practically all college subjects to stand upon their own merits, with the acid test being each subject's probable future value to the student.

For one thing, I believe that there will be a marked increase in the use of educational and industrial films for instructional purposes, since movies undoubtedly offer "the next best thing" to actual field and inspection trips, which are somewhat limited by various circumstances. The armed services have certainly shown the way and proved the value and effectiveness of such films in the training programs for practically all of their courses.

This increased use of instruction films may occur at the expense of certain subjects of questionable use to ceramists after graduation. These subjects may have to be omitted or whittled down so as to devote more time to this "realistic method" of instruction on subjects that will do the student the most good in later years. This is also a trend that probably can be chalked up to the emphasis and influence of the services' direct methods of getting to the core of things in their training programs.

Probably most ceramic schools employed educational films to some degree even before the war, as we did at Georgia Tech. In 1942, Dr. Lane Mitchell gave me a free rein to work on a comprehensive film about ceramics in Georgia. This was made in cooperation with the Atlanta public schools, since all the Atlanta high schools are interested in the art end of ceramics, as they teach clay modeling, making pottery, and have their own kilns.

Due to the wartime difficulties of obtaining film, gasoline, etc., this all-colored film was not completed until late 1943. It contains manufacturing scenes of brick, hollow tile, floor and wall tile, dinnerware, and porcelain enamel products (plus laboratory scenes at Tech's Ceramic Engineering Department), and outstanding structures employing ceramic structural products. It is used for showings by high schools, colleges, business and women's clubs, and has been received very enthusiastically.

I think that it would be appropriate for The Society to make a similar but even more comprehensive all-colored ceramic film as an important and effective part of its campaign to help foster the knowledge of and to advertise the ceramic industry.

With the marked increase of ceramic activity in the Southeast, such as the recent establishing of two glass plants in Georgia, I have long thought that a branch section of The Society should be organized there. This has been mentioned by various Tech ceramic staff members, but war conditions have delayed action on this. With the probable end of the European War near, I believe that an initial step could soon be taken. Professors Mitchell and Wysong also entered the Navy in 1943, and the Department was closed in November, after graduating the seniors.

Colonel Blake Van Leer, Georgia Tech's new President, is anxious to reopen this Department as soon as the situation permits, and this may be done this summer or fall. Here's hoping that an initial meeting of the ceramic manufacturers, clay-mine operators, and others can soon be held for organizing a branch section. I am sure that Atlanta and Georgia Tech anticipate being hosts to this gathering, which would probably be held at the Ceramic Engineering Department.

Sincerely yours,
W. CAREY HANSARD,
Lieutenant, U. S. Naval Reserves

★

San Francisco, Calif.,
2 March, 1945

Dear Ross & Co.:

The enclosed money order for $12.50 is sent in accordance with the invitation extended by the enclosed bill and correspondence which accompanied it to participate in the activities of The Society in 1945.

I'm very happy to become a member again, although I have no hopes of engaging in your activities in a real sense for at least two years. However, it will be pleasant to feel that I am again associated in some small way with ceramics, the vocation I hope to take up again when this thing is over.

My relationships with The Society have always been most pleasant, and I surely hope to renew some day the friendships and acquaintances I have made in school and industry.

As you suggested, a membership in The Society will help us to remember a little of our training and help to keep us abreast of advances being made.

You will note that I have a new address again; this time it's in the Fijis. This is by far the nicest place in which I've been located out here.

We're not too busy and we live very comfortably. I hope to travel a bit and see some of the sights soon.

This is the largest station I've supervised yet, so I'm learning quite a lot. The place is well equipped, too, having been established for some time.

Well, guess that's all, except that I'm sorry to be so late in answering. The mail had to chase me a bit.

Best regards to all.

Sincerely,
R. H. Dows,
Lieutenant, Army Air Forces

★

San Francisco, Calif.,
25 February, 1945

Dear Sir:

I am enclosing a money order along with the bill for 1945 dues.

Please continue to send the publications to my home address. Mail coming overseas is not sure of reaching its destination and I would like to keep my file complete.

However, I would like sent to me directly catalogues describing (1) experimental kilns, (2) work of the various kiln designing companies, and (3) machinery for both whiteware and structural clay products.

I am expecting to set up a small but completely modern ceramic plant near Spokane, Wash., after the war and would like to be in contact now with some of the equipment of manufacturing concerns.

Very truly yours,
DWIGHT F. GUSTAFSON,
Lieutenant, U. S. Army

★

Camp Houze, Texas,
11 March, 1945

Gentlemen:

I am writing to you upon referral by the U. S. Armed Forces Institute of Madison, Wis., for any information you may be able to give me concerning correspondence and extension courses offered by universities covering pottery manufacture on a mass-production scale. The U.S.A.F.I. does not include this type of course within its curriculum.

I hold a B.S. degree from Rhode Island State College in Business Administration but this course of study included no chemistry or physics, my knowledge of these sciences being confined to one year each of high-school chemistry and physics. In view of my educational background, please tell me what prerequisite courses, if any, you would recommend for my thorough comprehension of a course in pottery manufacture.

I am particularly interested in this type of work as I have made an extensive and first-hand study over a period of eight years of types of merchandise to be produced. After the war, I feel that I can sufficiently interest my company who employed me prior to my induction to become engaged in pottery manufacture if I can demonstrate my technical knowledge of the subject from a production standpoint along with the marketing experience I now have.

I will surely appreciate any suggestions and recommendations you may be able to give me in line with the foregoing. I will also appreciate your sending me names and addresses of trade journals and publications treating on this subject.

Respectfully yours,
ROY D. BEITTEL,
Private, U. S. Army

PERSONAL NOTES

J. B. AUSTIN CHOSEN CAMPBELL LECTURER

James Bliss Austin, assistant director of research of the U. S. Steel Corp., Kearny, N. J., has been selected to deliver the 1946 Edward de Mille Campbell Memorial Lecture of the American Society for Metals.

This lecture was set up in December, 1925, by the trustees of the American Society for Metals in honor of Edward de Mille Campbell, professor of chemistry and director of the chemical laboratory at the University of Michigan and an honorary member of the American Society for Metals. It is given every year at the annual meeting of the Society and in that respect is similar to the Edward Orton, Jr., Fellow Lecture of The American Ceramic Society.

Dr. Austin is Trustee of the Refractories Division of The American Ceramic Society. His photograph, biographical sketch, and extensive list of publications appeared in the April, 1943, issue of *The Bulletin*, pp. 116–17.

STAFF SERGEANT EDWARD L. WOODALL, JR.

Staff Sergeant Edward L. Woodall, Jr., a student member of The American Ceramic Society, has been officially listed as a prisoner of war in Germany. A gunner on a B-17 with the Eighth Air Force, he was shot down December 31, 1944.

Before entering the service, Sergeant Woodall was a student at the North Carolina State College, Raleigh, N. C.

C. GUY WURTSBAUGH WITH HALDEMAN POTTERIES

C. Guy Wurtsbaugh, Secretary-Treasurer of the Southern California Section during the past year, has joined the staff of Haldeman Potteries, 41 E. San Jose Ave., Burbank, Calif. He was formerly associated with Pacific Clay Products, Los Angeles, Calif.

INSTITUTE OF CERAMIC ENGINEERS

RECOMMENDED REPRESENTATIVES APPROVED BY E.C.P.D.

In the January, 1945, issue of *The Bulletin*, page 27, it was stated that the Council of E.C.P.D. had approved the appointment of representatives of the Institute on their regional inspection committees.

A fuller statement in reference to this appears in the Twelfth Annual Report of the Committee on Engineering Schools for the Year Ending September 30, 1944, as follows:

"The Council approved the addition to regional committees of the following individuals qualified to inspect courses in ceramic engineering as recommended by the Institute of Ceramic Engineers.

"*Region I:* GEORGE J. EASTER, Director of Research, Carborundum Co., Niagara Falls, N. Y.; *Region II:* FRANCIS C. FLINT, Hazel-Atlas Glass Co., Washington, Pa.; *Region III:* C. M. DODD, Dept. of Ceramic Engineering, Iowa State College, Ames, Iowa; *Region IV:* A. F. GREAVES-WALKER, Metals & Minerals Branch, OPRD, War Production Board 4400, Washington 25, D. C.; *Region V:* F. K. PENCE, Director, Division of Ceramics, Univ. of Texas, Austin 12, Texas; and *Region VI:* F. B. ORTMAN, President, Gladding, McBean & Co., 2901 Los Feliz Blvd., Los Angeles 26, Calif.

—M. F. BEECHER, *President*

NECROLOGY

PRIVATE JOHN S. YOUNG

Private John Shepard (Jack) Young, who before entering the Army was employed as a ceramic engineer at the Lava Crucible Co., Zelienople, Pa., was killed in action January 27, 1945, somewhere in the Luxembourg area.

Private Young entered the armed forces in June, 1944, and received his training at Fort McClelland, Ala. He went overseas about November 15, 1944.

He was graduated from the New York State College of Ceramics, Alfred, N. Y., and became associated with the Lava Crucible Company August 9, 1941, where he was in charge of the control laboratory and was also doing research work toward replacing critical materials formerly secured from Europe.

GEORGE W. HASKELL

George W. Haskell, vice-president and general sales manager of the Indiana Glass Co., Dunkirk, Ind., died February 13, 1945, at the age of fifty-eight.

Mr. Haskell was a native of Bowling Green, Ohio. He became associated with the Indiana Glass Company as sales manager in 1914 and was elected to the vice-presidency in 1931. During his business life in Dunkirk, he also took an active part in civic and political affairs and served as city councilman for twelve years.

He is survived by his widow and one son.

CAPTAIN STANLEY H. BOYLE

War is taking an increasing toll of members of The American Ceramic Society. Word has been received of the death of Captain Stanley H. Boyle, a member of The Society since 1938. Captain Boyle died in the Burma-India area February 10, 1945. His family has received few details of his death, but it is known that he had submitted to a sinus operation. He had been overseas two years and was scheduled to return home in March.

Captain Boyle was born August 27, 1912, in McNabb, Ill., and was graduated from the John Swaney High School in 1930. He received his B.S. degree in ceramic engineering from the University of Illinois in 1935. While a student there he was commissioned a second lieutenant in the R.O.T.C. After going to camp for several summers, he was advanced to first lieutenant. He was promoted to captain in 1942.

Before entering the Army, Captain Boyle was employed as a chemist by Davidson Enamel Products, Inc., Lima, Ohio, and was later associated with the American Viscose Corporation, a Du Pont rayon plant in Nitro, W. Va.

He is survived by his widow, Mrs. Hazel Jones Boyle, and a three-year-old daughter, of Dunbar, W. Va.; his parents, Mr. and Mrs. L. F. Boyle, of McNabb, Ill.; and four brothers and sisters.

T. A. McNICOL

T. A. McNicol, long associated with the pottery industry in East Liverpool, Ohio, and at one time president of the United States Potters Association, passed away February 7, 1945. He was seventy-five years old.

Before the illness preceding his death, Mr. McNichol headed a sales organization which represented feldspars, clays, and the like.

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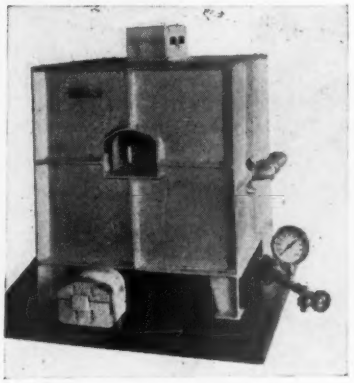
Write for Bulletin F-2



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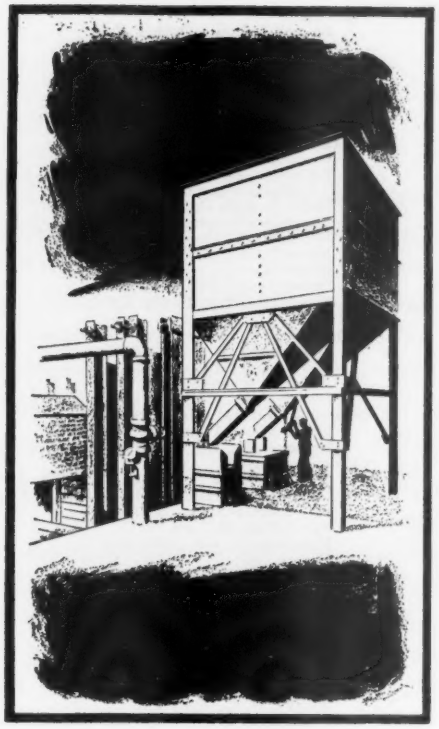

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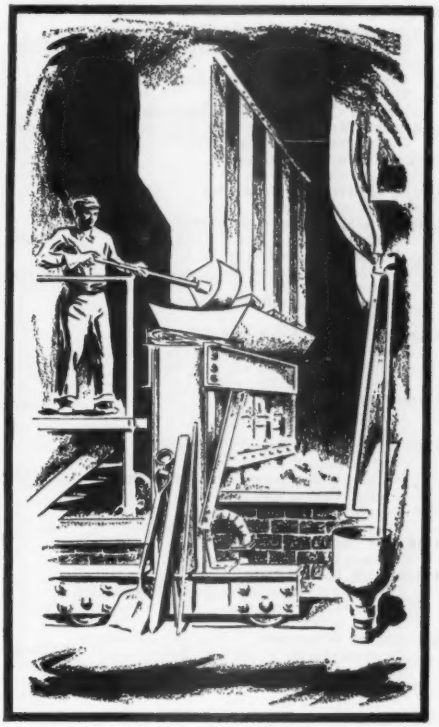

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Maxson, Elwyn L.
Spinks, H. C., Clay Co.

Clay (Modeling)
Potters Supply Co.

Clay (Potters)
Hammill & Gillespie, Inc.
Hommel, O., Co., Inc.
Kentucky Clay Mining Co.
Maxson, Elwyn L.
Spinks, H. C., Clay Co.

Clay (Process Equipment)
Lancaster Iron Works, Inc.

Clay (Sagger)
Georgia Kaolin Co.
Great Lakes Foundry Sand Co.
Hommel, O., Co., Inc.
Kentucky Clay Mining Co.
Maxson, Elwyn L.
Spinks, H. C., Clay Co.

Clay-Slip (Albany)
Hammill & Gillespie, Inc.
Hommel O., Co., Inc.
Maxson, Elwyn L.

Clay (Wad)
Kentucky Clay Mining Co.
Spinks, H. C., Clay Co.

Clay (Wall Tile)
Hammill & Gillespie, Inc.

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Design rings the bell when it's right. Color-designs on glassware—decorations that *sing*—have had a brilliant past, are having a brilliant present today—and will have an astonishing future! Clever design and matchless colors are your bet for big glassware sales tomorrow.

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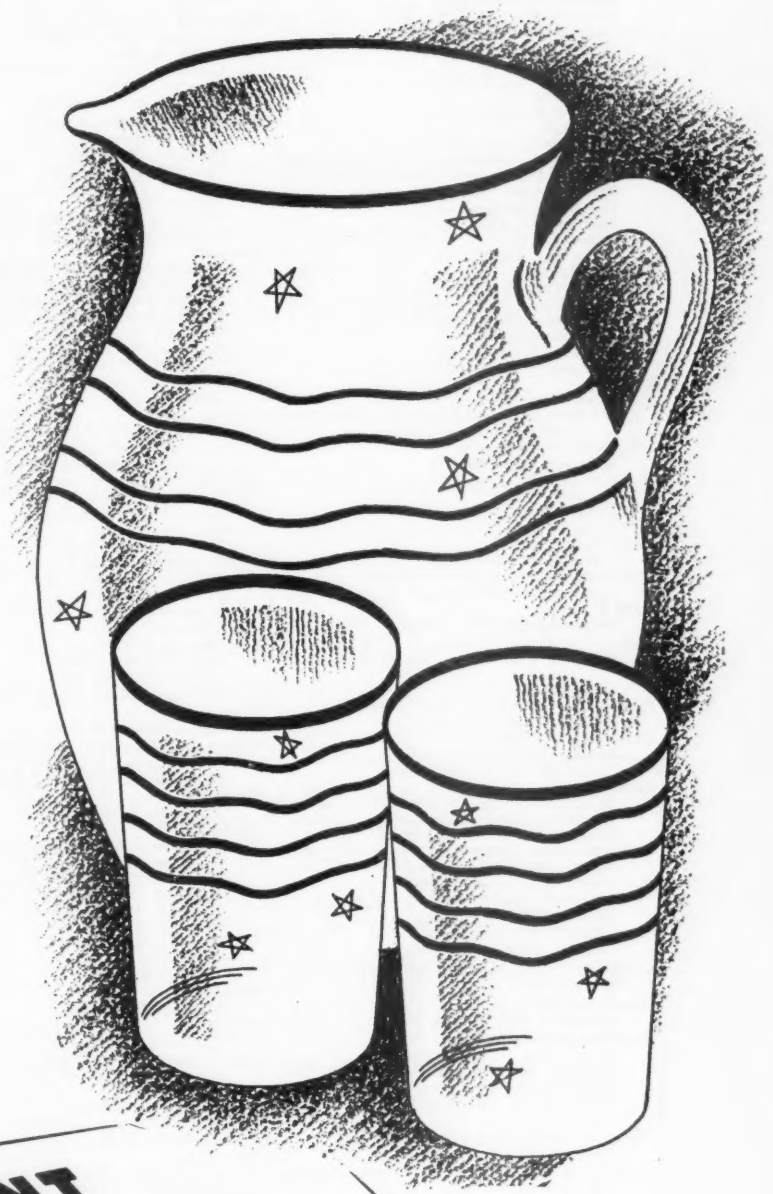

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for CERAMICS and GLASS

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Kentucky Clay Mining Co.
Maxson, Elwyn L.
Spinks, H. C., Clay Co.

Cleaners
Harshaw Chemical Co.
Pemco Corp.
Pennsylvania Salt Mfg. Co.
Solvay Sales Corp.

Clocks (Gauge Board)
Hommel, O., Co., Inc.

CO_2 Recorders
Leeds & Northrup Co.

Cobalt, Oxide
Drakenfeld, B. F., & Co., Inc.
Du Pont de Nemours, E. I., & Co., Inc., Electrochemicals Dept.
Ferro Enamel Corp.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Pemco Corp.
Vitro Mfg. Co.

Cobalt Sulphate
Drakenfeld, B. F., & Co., Inc.
Du Pont, de Nemours, E. I., & Co., Inc. Electrochemicals Dept.
Ferro Enamel Corp.
Harshaw Chemical Co.
Hommel, O., Co., Inc.

Colors
Drakenfeld, B. F., & Co., Inc.
Du Pont de Nemours, E. I., & Co., Inc., Electrochemicals Dept.
Ferro Enamel Corp.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Maxson, Elwyn L.
Pemco Corp.
Vitro Mfg. Co.

Combustion Control
Leeds & Northrup Co.

Combustion Meters (CO_2 Recorders)
Leeds & Northrup Co.

Cone Plaques
Industrial Ceramic Products, Inc.

Cones
Edward Orton, Jr., Ceramic Foundation
Maxson, Elwyn L.

Controllers—Automatic Tank Pressure
Leeds & Northrup Co.

Conveying Equipment
Frazier-Simplex, Inc.
Lancaster Iron Works, Inc.

Copper Oxide
Drakenfeld, B. F., & Co., Inc.
Harshaw Chemical Co.
Hommel, O., Co., Inc.

Cornwall Stone (Imported)
Drakenfeld, B. F., & Co., Inc.
Hammill & Gillespie, Inc.
Hommel, O., Co., Inc.
Maxson, Elwyn L.

Corundum Refractories
Corhart Refractories Co.

Crucibles (Filter, Melting, Ignition)
Norton Co.

Crushers (Clay)
Lancaster Iron Works, Inc.

Cryolite (see Kryolith)
Drakenfeld, B. F., & Co., Inc.
Du Pont de Nemours, E. I., & Co., Inc.
Harshaw Chemical Co.
Pennsylvania Salt Mfg. Co.
Vitro Mfg. Co.

Crystolon (Refractory Products)
Norton Co.

Cullet, Washing Plants, Incinerators, Crushers
Frazier-Simplex, Inc.

Cutters (Bar)
Industrial Ceramic Products, Inc.

Decalcomania
Commercial Decal, Inc.

Decorating Supplies
Commercial Decal, Inc.
Drakenfeld, B. F., & Co., Inc.
Du Pont de Nemours, E. I., & Co., Inc., Electro chemicals Dept.
Ferro Enamel Corp.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Vitro Mfg. Co.

Disintegrators
Lancaster Iron Works, Inc.

Dryer (Pipe Rack)
Lancaster Iron Works, Inc.

Dryers (Waste Heat, Continuous and Batch Type)
Harrop Ceramic Service Co.

Drying Machinery
Frazier-Simplex, Inc.
Lancaster Works, Inc.

Electrocast Refractories
Corhart Refractories Co.

Enameling Equipment (Complete)
Ferro Enamel Corp.
Hommel, O., Co., Inc.
Vitro Mfg. Co.

Enameling Furnaces
Carborundum Co.
Ferro Enamel Corp.
Hommel, O., Co., Inc.
Norton Co.

Enameling Iron (Sheet)
American Rolling Mill Co.

Enameling Muffles
Carborundum Co. (*Carbofrax*)
Maxson, Elwyn L.
Norton Co. (*Alundum*)

Enameling (Practical Service)
Ferro Enamel Corp.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Metal & Thermit Corp.
Pemco Corp.
Titanium Alloy & Mfg. Co.
Vitro Mfg. Co.

Enamels
Drakenfeld, B. F., & Co., Inc.
Du Pont de Nemours, E. I., & Co., Inc., Electrochemicals Dept.
Ferro Enamel Corp.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Maxson, Elwyn L.
Pemco Corp.
Vitro Mfg. Co.

Enamel Oxide
Drakenfeld, B. F., & Co., Inc.
Du Pont de Nemours, E. I., & Co., Inc., Electrochemicals Dept.
Ferro Enamel Corp.
Harshaw Chemical Co.
Hommel, O., Co., Inc.

Enamels (Porcelain)
Ferro Enamel Corp.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Pemco Corp.
Titanium Alloy & Mfg. Co.
Vitro Mfg. Co.

Engineering Service
Ferro Enamel Corp.
Frazier-Simplex, Inc.
Harrop Ceramic Service Co.

Epsom Salts
Innis, Speiden & Co.

Equipment (Porcelain Enameling)
Ferro Enamel Corp.
Hommel, O., Co., Inc.

Fans
Robinson Ventilating Co.

Feldspar
Clinchfield Sand & Feldspar Corp.
Du Pont de Nemours, E. I., & Co., Inc., Electrochemicals Dept.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Maxson, Elwyn L.
Pemco Corp.
Solvay Sales Corp.
Vitro Mfg. Co.

Filter Fabrics
Metakloth Company

Fire Brick
Carborundum Co.
Corhart Refractories Co.
Electro Refractories & Alloys Corp.
Norton Co.
Remmey, Richard C., Son Co.

Fire Brick—Process Equipment
Lancaster Iron Works, Inc.

Fire Clay
Great Lakes Foundry Sand Co.
Spinks, H. C., Clay Co.

Flint
Clinchfield Sand & Feldspar Corp.
Du Pont de Nemours, E. I., & Co., Inc.
Great Lakes Foundry Sand Co.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Maxson, Elwyn L.
Pemco Corp.

Flint Pebbles
Clinchfield Sand & Feldspar Corp.
Hommel, O., Co., Inc.
Maxson, Elwyn L.
Vitro Mfg. Co.

Flint (Soft decomposed Cararra)
Innis, Speiden & Co.

Floating Construction for Tunnel Kiln Cars
Electro Refractories and Alloys Corp.

Floors (Non-Slip)
Norton Co.

Fluorspar
Harshaw Chemical Co
Hommel, O., Co., Inc.

French Flint
Maxson, Elwyn L.

Frit
Ferro Enamel Corp.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Maxson, Elwyn L.
Pemco Corp.
Titanium Alloy & Mfg. Co.
Vitro Mfg. Co.

Frosting Mixtures
Drakenfeld, B. F., & Co., Inc.
Harshaw Chemical Co.
Hommel, O., Co., Inc.

Fuel Oil Systems and Control Stokers
Frazier-Simplex, Inc.
Harrop Ceramic Service Co.

Furnaces
Carborundum Co. (*Carboradiant*)
Ferro Enamel Corp.
Frazier-Simplex, Inc.
Harrop Ceramic Service Co.
Hommel, O., Co., Inc.
Swindell-Dressler Corp.

Furnaces (Laboratory)
Remmey, Richard C., Son Co.

Furnaces, Enameling
Ferro Enamel Corp.
Swindell-Dressler Corp.

Gauges, Draft (Recording, Indicating)
Leeds & Northrup Co.

Gauges, Pressure
Leeds & Northrup Co.

Glass Bending Ovens, Glass Decorating Machines
Frazier-Simplex, Inc.

Glass Equipment (Batch Mixer)
Lancaster Iron Works, Inc.

Glass Furnace Refractories
Corhart Refractories Co.

Glass Melting Tanks and Furnaces
Frazier-Simplex, Inc.

Glass Sand
Great Lakes Foundry Sand Co.

Glass Thickness Gauge
Bausch & Lomb Optical Co.

Glaze and Body Spar
Clinchfield Sand & Feldspar Corp.
Du Pont de Nemours, E. I., & Co., Inc., Electrochemicals Dept.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Maxson, Elwyn L.
Pemco Corp.
Vitro Mfg. Co.

Glazes and Enamels
Drakenfeld, B. F., & Co., Inc.
Du Pont de Nemours, E. I., & Co., Inc., Electrochemicals Dept.
Ferro Enamel Corp.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Maxson, Elwyn L.
Pemco Corp.
Titanium Alloy & Mfg. Co.
Vitro Mfg. Co.

Glaze Spar
Clinchfield Sand & Feldspar Corp.
Du Pont de Nemours, E. I., & Co., Inc., Electrochemicals Dept.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Maxson, Elwyn L.

Goggles
Bausch & Lomb Optical Co.
Hommel, O., Co., Inc.

Gold
Drakenfeld, B. F., & Co., Inc.
Du Pont de Nemours, E. I., & Co., Inc., Electrochemicals Dept.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Vitro Mfg. Co.

Gold Decorations
Du Pont de Nemours, E. I., & Co., Inc., Electrochemicals Dept.
Harshaw Chemical Co.
Hommel, O., Co., Inc.

Granulators
Lancaster Iron Works, Inc.

Grinding Wheels
Carborundum Co. (*Carborundum and Aloxite*)
Electro Refractories & Alloys Corp.
Norton Co. (*Alundum-Crystolon*)

Gums: *Arabic*—Amber Sorts, Powdered Grained
Ghatti—Powdered, Granular, Crude
Locust Bean—Powdered
Tragacanth—Ribbon—Flake—Powdered
Innis, Speiden & Co.

Hearths
Carborundum Co. (*Carbofrax* heat treating)
Corhart Refractories Co.
Norton Co. (*Crystolon*)
Remmey, Richard C., Son Co.

Hearths (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.
Norton Co.
Remmey, Richard C., Son Co.

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Pennsylvania Salt Mfg. Co.

Ilmenite
Foote Mineral Co.
Orefraction, Inc.

Iron (Enameling)
American Rolling Mill Co.

Iron Oxide
Drakenfeld, B. F., & Co., Inc.
Du Pont de Nemours, E. I., & Co., Inc.
Foote Mineral Co.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Pemco Corp.
Vitro Mfg. Co.

Kaolin
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Maxson, Elwyn L.
Vitro Mfg. Co.

Kiln Furniture (Silicon Carbide, Semi-Silicon Carbide) (Refractory)
Carborundum Co.
Electro Refractories & Alloys Corp.
Ferro Enamel Corp.—Ceramic Supply Div.
Maxson, Elwyn L.
Remmey, Richard C., Son Co.

Kilns, China (Decorating)
Drakenfeld, B. F., & Co., Inc.
Ferro Enamel Corp.—Allied Engineering Div.
Frazier-Simplex, Inc.
Harrop Ceramic Service Co.
Hommel, O., Co., Inc.
Swindell-Dressler Corp.

Kilns (Electric, Circular, Tunnel)
Ferro Enamel Corp.—Allied Engineering Div.
Harrop Ceramic Service Co.
Maxson, Elwyn L.
Swindell-Dressler Corp.

Kilns (Laboratory)
Remmey, Richard C., Son Co.

Kryolith (see Cryolite)
Pennsylvania Salt Mfg. Co.

Laboratory Ware
Norton Co.

Lehr Tile (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.
Electro Refractories & Alloys Corp.

Lehrs
Frazier-Simplex, Inc.
Swindell-Dressler Corp.

Lehrs (Electric or Fuel Heated)
Frazier-Simplex, Inc.
Swindell-Dressler Corp.

Lehr Loaders
Frazier-Simplex, Inc.

Linings (Furnace Refractory, Block Refractory Plate, Brick, and Tile)
Carborundum Co.
Corhart Refractories Co.
Electro Refractories & Alloys Corp.
Maxson, Elwyn L.
Norton Co.
Remmey, Richard C., Son Co.
Vitro Mfg. Co.

Lithium Carbonate
Drakenfeld, B. F., & Co., Inc.
Foote Mineral Co.
Hommel, O., Co., Inc.

Lithium Minerals
Foote Mineral Co.

Magnesia (Fused)
Electro Refractories & Alloys Corp.
Norton Co.

Magnesia (Sintered,Calcined)
Drakenfeld, B. F., & Co., Inc.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Pemco Corp.

Magnesite
Drakenfeld, B. F., & Co., Inc.
Du Pont de Nemours, E. I., & Co., Inc.
Foote Mineral Co.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Vitro Mfg. Co.

Magnesite Calcined
Foote Mineral Co.
Harshaw Chemical Co.
Hommel, O., Co., Inc.

Magnesium Carbonate
Drakenfeld, B. F., & Co., Inc.
Ferro Enamel Corp.
Harshaw Chemical Co.
Hommel, O., Co., Inc.

Manganese Dioxide
Drakenfeld, B. F., & Co.
Ferro Enamel Corp.
Foote Mineral Co.
Hammill & Gillespie
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Vitro Mfg. Co.

Manganese (Oxide)
Corhart Refractories Co.
Drakenfeld, B. F., & Co., Inc.
Ferro Enamel Corp.
Harshaw Chemical Co.
Hommel, O., Co., Inc.

Masks (Breathing)
Drakenfeld, B. F., & Co., Inc.
Hommel, O., Co., Inc.

Metals (Porcelain Enameling)
American Rolling Mill Co.

Micronized Products
Pemco Corp.

Microscope, Laboratory
Bausch & Lomb Optical Co.

Microscopes (Polarizing)
Bausch & Lomb Optical Co.
Harshaw Chemical Co.
Spencer Lens Co.

Microscopes (Stereoscopic)
Bausch & Lomb Optical Co.
Harshaw Chemical Co.
Spencer Lens Co.

Minerals
Clinchfield Sand & Feldspar Corp.
Drakenfeld, B. F., & Co., Inc.
Du Pont de Nemours, E. I., & Co., Inc., Electrochemicals Dept.
Foote Mineral Co.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Orefraction, Inc.
Vitro Mfg. Co.

Mixers
Clearfield Machine Co.

Mixers (Batch)
Clearfield Machine Co.
Lancaster Iron Works, Inc.

Mixers (Concrete, Paving, Road Paving, Plaster, Asphalt, Truck, Mortar, Bituminous)
Lancaster Iron Works, Inc.

Mixers (Laboratory)
Lancaster Iron Works, Inc.

Mold Sanders
Lancaster Iron Works, Inc.

Muffles (Furnace) (Laboratory)
Carborundum Co. (*Carbofrax*)
Electro Refractories & Alloys Corp.
Frazier-Simplex, Inc.
Maxson, Elwyn L.
Norton Co.
Remmey, Richard C., Son Co.

Mullers (Batch)
Clearfield Machine Co.
Lancaster Iron Works, Inc.

Mullite Refractories
Corhart Refractories Co.
Remmey, Richard C., Son Co.

Muriatic Acid
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Pennsylvania Salt Mfg. Co.

Needle Antimony
Foote Mineral Co.
Harshaw Chemical Co.
Hommel, O., Co., Inc.

Nepheline Syenite
Great Lakes Foundry Sand Co.
Maxson, Elwyn L.

Nickel Salts
Drakenfeld, B. F., & Co., Inc.
Harshaw Chemical Co.
Hommel, O., Co., Inc.

Nitrates (Cobalt, Sodium)
Drakenfeld, B. F., & Co., Inc.
Du Pont de Nemours, E. I., & Co., Inc.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Vitro Mfg. Co.

Nitre
Harshaw Chemical Co.
Hommel, O., Co., Inc.

Norbide (Norton Boron Carbide)
Norton Co.

Olivine
Clinchfield Sand & Feldspar Corp.
Du Pont de Nemours, E. I., & Co., Inc., Electrochemicals Dept.

Opacifiers
Drakenfeld, B. F., & Co., Inc.
Du Pont de Nemours, E. I., & Co., Inc., Electrochemicals Dept.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Maxson, Elwyn L.
Metal & Thermit Corp.
Pemco Corp.
Pennsylvania Salt Mfg. Co.
Titanium Alloy & Mfg. Co.
Vitro Mfg. Co.

Overglaze Colors
Drakenfeld, B. F., & Co., Inc.
Du Pont de Nemours, E. I., & Co., Inc., Electrochemicals Dept.
Ferro Enamel Corp.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Maxson, Elwyn L.

Oxides
Drakenfeld, B. F., & Co., Inc.
Du Pont de Nemours, E. I., & Co., Inc., Electrochemicals Dept.
Ferro Enamel Corp.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Maxson, Elwyn L.
Metal & Thermit Corp.
Pemco Corp.
Titanium Alloy & Mfg. Co.
Vitro Mfg. Co.

Palladium Decorations
Du Pont de Nemours, E. I., & Co., Inc., Electrochemicals Dept.
Hommel, O., Co., Inc.

Pans—Wet and Dry
Clearfield Machine Co.

Pins
Hommel, O., Co., Inc.
Industrial Ceramic Products, Inc.
Potters Supply Co.

Placing Sand
Great Lakes Foundry Sand Co.

Platinum Decorations
Du Pont de Nemours, E. I., & Co., Inc., Electrochemicals Dept.
Hommel, O., Co., Inc.

Polariscopes
Frazier-Simplex, Inc.

Porcelain Enameling Service (Practical)
American Rolling Mill Co.
Du Pont de Nemours, E. I., & Co., Inc., Electrochemicals Dept.
Ferro Enamel Corp.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Pemco Corp.
Titanium Alloy & Mfg. Co.
Vitro Mfg. Co.

Porcelain Enamels
Ferro Enamel Corp.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Pemco Corp.
Titanium Alloy & Mfg. Co.
Vitro Mfg. Co.

Potash (Carbonate)
Du Pont de Nemours, E. I., & Co., Inc.
Harshaw Chemical Co.
Hommel, O., Co.,Inc.
Innis, Speiden & Co.
Solvay Sales Corp.
Vitro Mfg. Co.

Potassium Hydroxide
Innis, Speiden & Co.
Solvay Sales Corp.

Producer Gas Plants
Frazier-Simplex, Inc.

Pug Mills
Lancaster Iron Works, Inc.

Pyrites (Natural Iron Sulphide)
Foote Mineral Co.
Harshaw Chemical Co.
Hommel, O., Co., Inc.

Pyrometer Tubes
Carborundum Co.
Leeds & Northrup Co.
Maxson, Elwyn L.
Montgomery Porcelain Products Co.

Pyrometer Tubes (Refractory and Hard Porcelain)
Electro Refractories & Alloys Corp.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.
Norton Co.

Pyrometers (Optical, Radiation, Surface, Immersion, Needle)
Leeds & Northrup Co.

Pyrometric Cones
Du Pont, de Nemours, E. I., & Co., Inc.
Edward Orton, Jr., Ceramic Foundation
Maxson, Elwyn L.

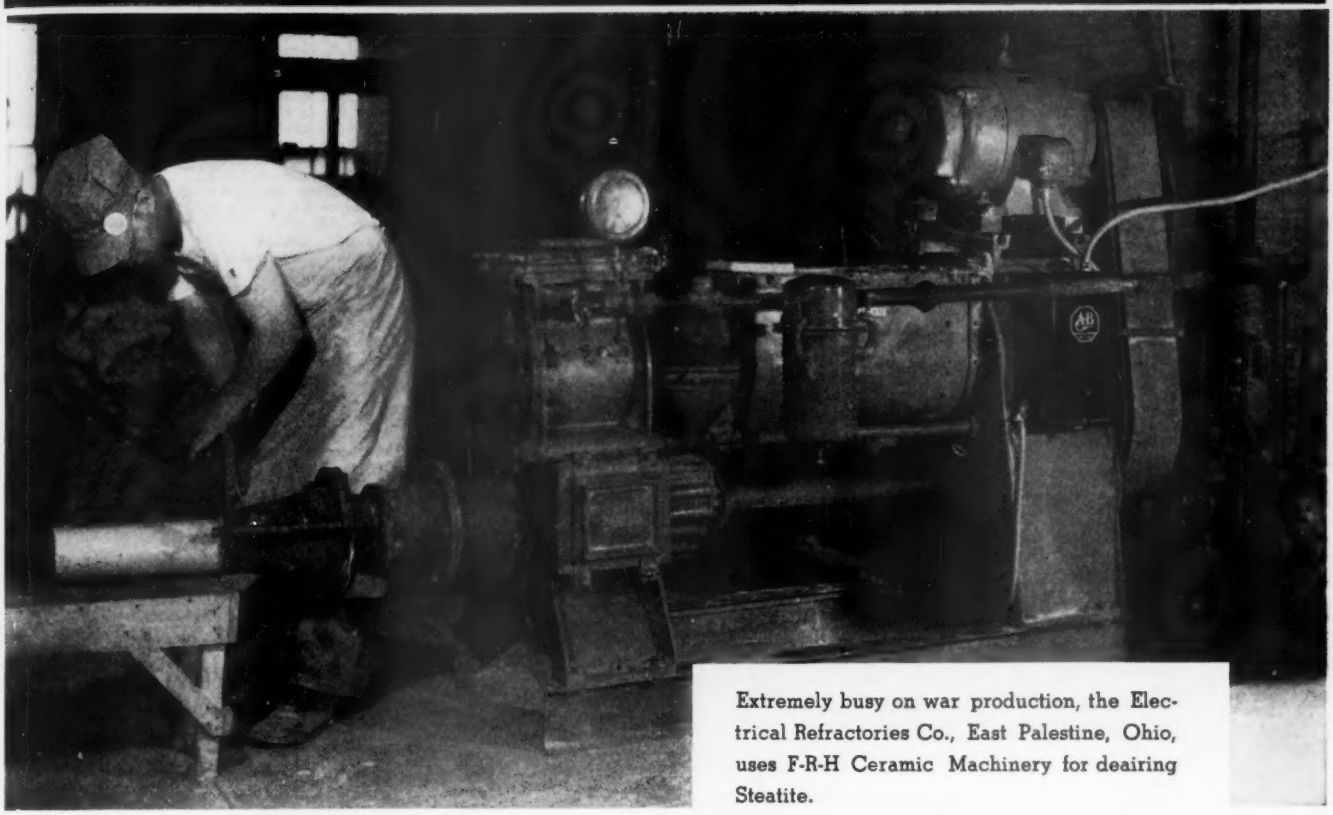
Pyrophyllite
Clinchfield Sand & Feldspar Corp
Du Pont de Nemours, E. I., & Co., Inc., Electrochemicals Dept.

Quartz (Granulated)
Clinchfield Sand & Feldspar Corp.
Du Pont de Nemours, E. I., & Co., Inc.

Ramming Mixes
Corhart Refractories Co.

Raw Material Handling Equipment
Frazier-Simplex, Inc.

OWNER SATISFACTION . . .



Extremely busy on war production, the Electrical Refractories Co., East Palestine, Ohio, uses F-R-H Ceramic Machinery for deairing Steatite.

AND REPEAT ORDERS PROVE IT!

Would you buy another? When the answer is "yes" it's the best evidence of merit in any piece of equipment. Production economies provided by efficient and durable F-R-H DeAiring Machines result in many repeat orders for this ceramic machinery.

Typical of the recommendations from owners of F-R-H machines is the one from The Electrical Refractories Co. "...we like it—we bought the second machine." Owner satisfaction, backed by a repeat order, is the proof of high quality.

On all ceramic assignments, F-R-H has consistently given satisfaction to owners. Investigate these machines that increase production, lower operating costs and bring higher net income returns. Models and sizes for all clay working needs.

THE FATE-ROOT-HEATH CO.
Plymouth, Ohio, U. S. A.

BUY MORE U. S. WAR BONDS!

PLYMOUTH Industrial Locomotives

F·R·H
Clay Working Machinery

SILVER KING Industrial Tractors

Recorders, CO_2
Leeds & Northrup Co.

Recorders, Draft
Leeds & Northrup Co

Recorders, Tank Pressure
Leeds & Northrup Co.

Refractometers
Bausch & Lomb Optical Co.
Electro Refractories & Alloys Corp.
Spencer Lens Co.

Refractories
Carborundum Co.
Corhart Refractories Co.
Electro Refractories & Alloys Corp.
Norton Co.
Remmey, Richard C., Son Co.

Refractory Aggregate Grain
Corhart Refractories Co.

Refractory Aggregate Grain for Catalytic Processes
Corhart Refractories Co.

Refractory Materials
Carborundum Co.
Corhart Refractories Co.
Electro Refractories & Alloys Corp.
Norton Co.
Remmey, Richard C., Son Co.
Titanium Alloy & Mfg. Co.

Respirators
Drakenfeld, B. F., & Co., Inc.
Hommel, O., Co., Inc.

Rutile
Drakenfeld, B. F., & Co., Inc.
Foote Mineral Co.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Metal & Thermit Corp.
Orefraction, Inc.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

Saggers
Carborundum Co.
Electro Refractories & Alloys Corp.
Ferro Enamel Corp.—Ceramic Supply Div.
Maxson, Elwyn L.
Norton Co.
Potters Supply Co.
Remmey, Richard C., Son Co.

Salt Cake
American Potash & Chemical Corp.
Drakenfeld, B. F., & Co., Inc.
Harshaw Chemical Co.
Hommel, O., Co., Inc.
Pennsylvania Salt Mfg. Co.

Sandblast Sand
Great Lakes Foundry Sand Co.

Sand Grinders and Sifters
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Harshaw Chemical Co.
Hommel, O., Co., Inc.
Vitro Mfg. Co.

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Silica (Fused)
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Du Pont de Nemours, E. I., & Co., Inc.
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Titanium Alloy Mfg. Co.

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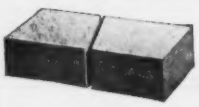

This acid brick intended for a chemical plant acid chamber was cut completely in two, in just 37 seconds.

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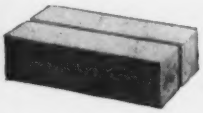

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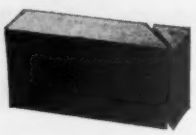

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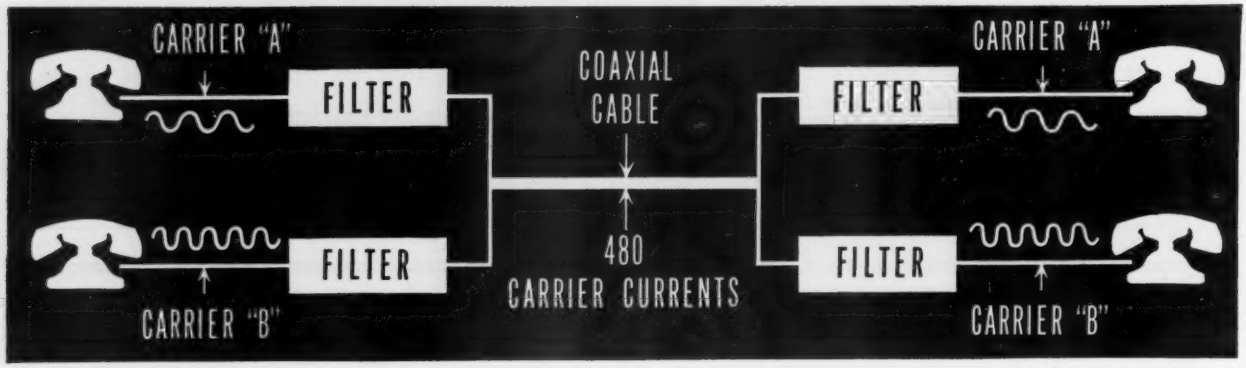

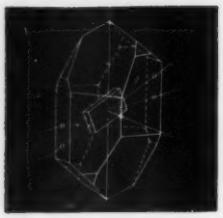

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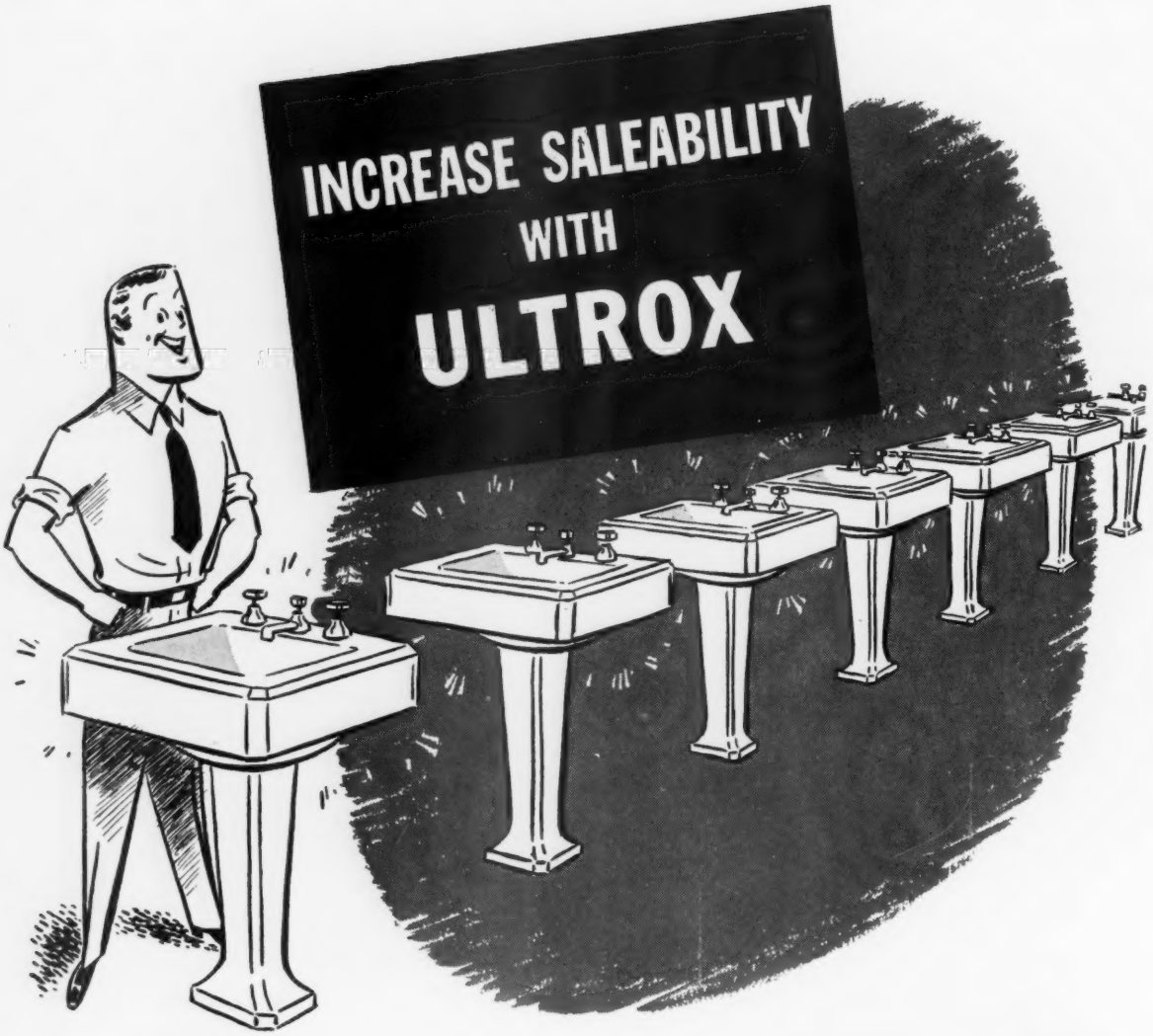

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